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Study of Gastric Acid Secretion

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Contents

Preface

Early diagnosis of diseases of the stomach with recognition of its functional disturbances is an essential stage in the development of gastroenterology Determination of the pattern governing gastric acid secretion plays an important role in this connection Many various methods are used for studying gastric function, among which measurement of pH in the zones where acid secreting and neutralizing gastric glands are located is winning ever more recognition

Taking into account the fact that the modern surgical clinic requires more accurate methods for functional diagnostics of gastro-intestinal diseases we made an attempt to study the possibility of every-day use of pH-metry as an objective method for investigation of acid secretion in the stomach and also to find other means of using it in surgical practice The present work is a continuation of the study in the clinical aspect which was begun by Linar.

This problem was studied in experiments and in the clinic at the Diagnostics Department of the Center of Gastroenterology and Dietetics (CGED) of the Ministry of Health of the Latvian Soviet Socialist Republic. We examined more than 16 000 patients using methods of pH-me-
were [illegible] d which, in our opinion,
interest, [illegible] ..iods of study were

of the sto-
acid sec-

Chapter 1

pH-Probes, Apparatus and Techniques of Introducing pH-Probes

Electrometric determination of pH is based on the following principle: when electrodes are immersed into solution the arising chemical processes are attended wi the production of electric energy, just as it happens galvanic cells (Vinogradova, 1956, Linar, 1968). The d ference of potentials between the measuring electrode the reference electrode forms the electromotive force (EM whose value depends on the activity of hydrogen ions. the electrolyte This difference is insignificant. A dir current amplifier to which an indicating or recording vice is connected is used for measuring EMF.

Thus, to study the pH in the upper portion of the gast intestinal tract by means of the probe technique it is cessary to incorporate into the olive of the probe a meas ing and reference electrodes. A glass electrode (Demlir 1964, Hemmati, 1968) or antimony electrode (Linar, 19 Pantsyrev et al, 1972) is most commonly used as the meas ing electrode The glass electrode possesses high pre sion and sensitivity but, due to its fragility, it requi protective casing if it is used in a pH-probe The antimo electrode is less precise but yields to treatment easier w is necessary for fitting it into the pH-probe. A calon electrode is commonly applied as the reference (auxilia electrode.

In the USSR a variety of pH-probes with antimor calomel electrodes are used. Linar's (1964) gastric pr should be recognized as the basic one for all of them.
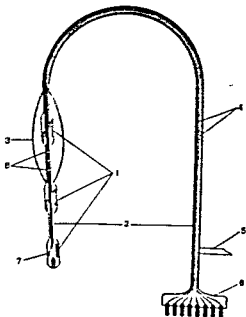
Fig 1 Schematical representation of a multi-channel pH-probe

1, olives of the probe 2 rubber probe 3, thin rubber balloon, 4 wires stretch from antimony-calomel electrodes and micro-thermo-resistance 5 rubber tube leading to battery of metal capsules of a gastropolygraph 6 plug of the pH and socket unit 7, micro-therm-resistance 8 openings in the rubber probe for passage of air into the balloon

Multi-channel pH-Probes of Closed Type

A probe with two antimony electrodes was manufactured in Henning's Laboratory (Henning et al , 1951) but its design does not allow its wide application in clinical practice. Linar's gastric probe [illegible] for studying several portions of the [illegible] end and an intermediate pH [illegible] probe is currently mar[illegible] [illegible]tyrev et al, 1972)

into the olives of these probes, and for studying motor activity of the stomach a thin rubber balloon may be connected to the probe In other words, the design of multi-channel pH-probes depends on the purpose of the hypothetic study (Fig 1)

Probes of Portable pH-Meter with a System for Collecting Gastric Juice

When studying the acid-secreting activity of the stomach it sometimes becomes necessary to collect gastric juice to determine the hour tension of gastric secretion and the activity of proteolytic enzymes, to carry out microscopy, etc Besides, now that intragastric pH-metry is being introduced into clinical practice, the practising physicians can see the advantages of the method being described, as they compare its data with those simultaneously obtained by titration.

We strove to make a probe of the simplest design (L ia et al , 1971) for the examination of the internal medium in two portions of the stomach with simultaneous collection of gastric juice For this purpose, in addition to the system for collecting gastric juice, i e the olive with a vinyl chloride tube connected to it (Fig. 2), we incorporated in it two pH-olives for determining *the pH* of the gastric bod[illegible] or convenience o[illegible] all call the olive [illegible]

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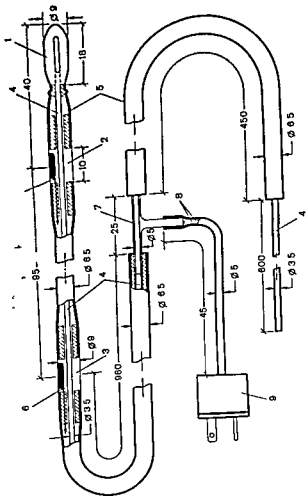
ø 6 5

corresponds to the outer diameter of the ends of the electrodes, while the inner one to the diameter of the middle opening in the electrodes. The Teflon bushings are put into a special metal mould which consists of two parts The mould is placed in a vertical position and filled with melted antimony. The latter envelops the Teflon bushings and,

bushings, e g of polyethylene or organic glass After the glue dries the *antimony electrode is ready for assembling* into a pH-microprobe.

The pH-microprobe thus made is more durable At present we make four-channel pH-microprobes with an inner system for infusing fluids by the drip method (Fig 4).

Probes for Combined Study of the Stomach d Duodenum

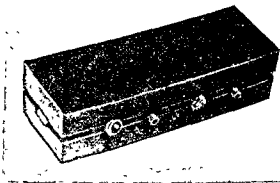



Fig 4 Metal mould with antimony ingots

In assembling the probe the connecting vinyl chlor tubes are filled with barium sulphate powder to prov a clear outline of the probe during X-ray study. Tests h shown that otherwise it is difficult to watch the positi of the probe because the shadow of the vinyl chloride tu seen during X-ray study is very small.

At present we use two-, three- and four-channel pH-m croprobes. Two- and three-channel microprobes are inten ed for studying acid-secreting function in patients wl tolerate the probing procedure poorly, and for invest gating gastro-oesophageal reflux. Four-channel microprob are used in prolonged examination of the acid-secre

therefore the electrodes often break.

In order to correct this defect we have been using sinc 1973 another technique for producing antimony electrode for pH-microprobes (Leja, 1974). Special thermoresistan bushings are first made of Teflon. Their outer diamete

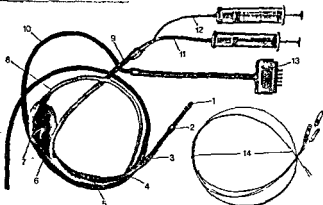
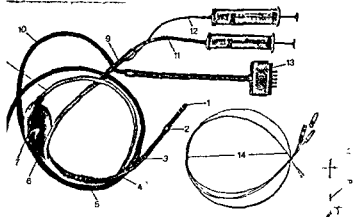



Fig. 5. Probe for combined examination of the stomach and duodenum

trodes are fitted into the probe so that when it is introduced the distal electrode is in the upper portion of the duodenum, the intermediate one in the pyloric antrum and the proximal in the body of the stomach The calomel electrode is brought out. A balloon is attached to the probe proximal to the body electrode, air to the balloon passes between the inner vinyl chloride tube and the outer probe, here also pass wires from the antimony electrodes to the plug of the plug and socket unit

Four pH-olives and a third channel distinguish the second model probe (Fig. 5) The fourth pH-olive is distal to the hollow olive for collecting bile and pancreatic secretion, and, with the probe being introduced, it is located in the lower portion of the duodenum. The third channel of the probe opens above the balloon, at the entrance tc

Fig. 4. Schematical representation of four-channel pH-microprobe with a system for enteral drip infusion of fluids

1, pH-olive for the lower portion of the duodenum, *2*, pH-olive for the upper portion of the duodenum, *3*, antral pH-olive, *4*, body pH-olive *5*, wires from antimony electrodes, *6*, plug of the ... *7*, spiral tube, *8*, bushing of intermediate ...

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the stomach, and, just like the system for collecting d
duodenal contents, there is a single all-side tube wh
passes through the whole probe

The Calomel Electrode

In all the above-described probes a common calom
electrode serves as the reference electrode. This princi
is used in a two-channel pH probe of the closed type m
nufactured on a mass scale. It has a calomel electrode s
tuated in the antral olive, which is common for the bo
and antral antimony electrodes. Linar (1965) cond
special investigations which showed that an external ca
omel electrode may be employed. An additional electr
which was attached to the patient's hand or leg was co
nected with the recording apparatus parallel to a pro
fitted with antimony and calomel electrodes. Alterna
connection of the probe calomel electrode and the add
tional calomel electrode showed that the EMF of the ant
mony and the external calomel electrodes was less by 2 p
cent than the EMF of the antimony and the internal calom
electrodes. In 1972 we compared 434 readings of calom
electrodes located in the probe, in the mouth and on th
skin of the hand of 30 patients. After treatment of th
data obtained by means of the test for paired observatio
it was established that the differences between the readin
of these calomel electrodes were statistically signific
but not high. Thus, intragastric pH value shown by th
calomel electrode placed in the mouth was by 0.66 highe
on the average, than that recorded by the calomel electro
of the probe. The pH readings of the external calomel elec
trode were by 0.26 lower, on the average, than those o
the probe calomel electrode. Consequently, taking thes
data into consideration one may correct the results obtain
and make successful use of the advantages of the extern
calomel electrode. These advantages make it possible t
apply in clinical practice pH-microprobes and various com
bined probes without increasing their external diamete
which is of essential importance for the patient who is bein
examined.

The design of the internal and external calomel elec

trodes is in essence the same The end pH olive is represented schematically in illustration (Fig 6)

The calomel electrode is a filled tunnel in the body of the pH-olive

Filling the calomel electrode. With the olive held erect, the electrode is filled as follows. a platinum wire pressed into the body of the probe olive is covered with a layer of pure mercury by means of a fine pipette The tunnel in the olive is then filled with saturated potassium chloride solution The mercury layer is covered with a thin layer of calomel paste prepared from calomel, carefully ground with mercury, and potassium chloride (Linar, 1968) Several crystals of potassium chloride are placed above the calomel paste The remaining part of the tunnel (above the potassium chloride crystals) is filled with pieces of filter paper or chemically pure asbestos impregnated with saturated potassium chloride solution, taking special care not to distort the drop of mercury When discharging an old or filling a new calomel electrode it is advisable to use fine glass pipettes and injection needles with the sharpened tip bent. The calomel electrode should be used only when 24 hours passed after it had been filled (Linar, 1968) so that its contents would become adjusted.

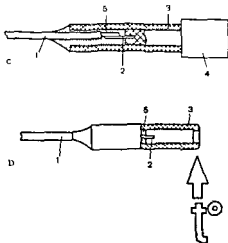
Fig 6 Schematical representation of the end pH-olive

1, antimony electrode, *2*, platinum wire, *3*, pure mercury, *4*, calomel paste, *5*, potassium chloride crystals, *6*, filter paper *7*, polystyrene casing, *8*, wires from antimony and calomel electrodes

The filled calomel electrode should be protected from drying for which purpose it is covered with a rubber cap filled with saturated potassium chloride sol...

end of the platinum wire In one end of the technological rod a hole 2.5 mm deep is drilled for fitting it on the platinum wire, on the other end there is a handle

The glass tube (the body of the electrode) is then filled with insulating material which can harden, e.g epoxy filling The technological rod together with the platinum wire and the electrode wire are inserted into the body of the electrode (Fig 7C), squeezing the filling out of it During hardening of the insulating material the technological rod is taken out and, after complete hardening, an insulation (rubber, vinyl chloride) tube is put on the body of the electrode, while the free end of the electrode wire is connected to the electric plug for joining the electrode to the place of work The outer butt-end of the electrode body is fused over flame (Fig. 7D)

The external calomel electrode is transparent. It is easy

ire 3, glass tube (electrode body), 4, technological rod, C, insertion of the chnological rod into the electrode body 1, electrode wire 2, platinum wire, , electrode body 4, handle of technological rod 5, insulating filler D, the uter end of the electrode body is melted the same designations as in Fig 7C

to fill and, when necessary, to clean it. This electrode been tested in the examination of 3000 patients and shown good efficacy.

Gastric Acidimechanograph and Gastropolygraph

The gastric acidimechanograph and gastropolygraph w elaborated at the Research Institute of Experimental a Clinical Medicine under the direction of Prof. Linar

The acidimechanograph is intended for determining the I of one of the portions of the stomach and gastric mo activity. During the development of this method it w established that it was not sufficient to record the pH just one gastric portion. At present most of the acidimec nographs are rebuilt and a second channel is attached them for pH measurement.

In 1964 the VEF Plant manufactured a four-chan IIIK-64 gastropolygraph (Fig. 8), it is supplied with f recording galvanometers which are connected with f amplifiers. Such a multichannel system of the gastro lygraph design enables one to use it for simultaneous cording of the indices of acid secretion and heat prod tion in several portions of the stomach. Like the acid chanograph, the gastropolygraph is supplied with a bat of metal capsules and an intragastric pressure manon for recording the motor activity of the stomach, and with three relay markers, time, stimulation, and the shold of patient's subjective pressosensitivity. Auxi markers are attached to an additional panel of the ga polygraph which are intended for tracing additional on the gastropolygram. The amplifiers of the IIIK-64 tropolygraph can be easily removed and mutually repla

Portable pH-Meters

In the above-described apparatus for automatic pH cording the principle of attachment of one amplifie each olive of the probe is used. As a result only one pat at a time can be examined by means of the gastric ac mechanograph and gastropolygraph. This, of course, not satisfy ... irements of the clinic. Therefore table pH ... re design... the Research Insti

of Experimental and Clinical Medicine (Linar, 1970). other principle is applied in these apparatus: a single amplifier is alternately switched from one patient to other.

A portable OP-2 pH-meter has been used for more four years in the Diagnostics Department at the (Fig 9) Portable pH-meters manufactured by the tekhnika Factory of the Latvian SSR are currently used. More than 9500 examinations conducted by apparatus show that it can be used in clinical practice.

Introduction of pH-Probes

Routine examination of the functional state of the ach by means of the acidimechanograph, gastropoly or portable pH-meter is conducted in the morning fasting stomach When pH-probes with a balloon are all the air is aspirated from the balloon before th amination so that it fits closely to the wall of the during its introduction and causes no unpleasant sensations in patients

A probe may be introduced passively or actively. In the first case the patient sits with his head slightly bent for ward and he swallows the probe without anybody's assistance, commonly used probes are introduced through the mouth In the second case the examiner introduces the probe; during the procedure it is advisable to press the patient's tongue lightly with the index finger of the left hand and with the index finger of the right hand to direct the probe in the mouth so that it cannot bend. Patients experience unpleasant sensations when the distal olive o the probe passes from the oral portion of the throat to the middle third of the oesophagus. After this the probe advances easily with the patient breathing deeply. Patients usually find active insertion to be easier than the passive insertion of the probe

Surface anaesthesia is sometimes applied to the throat mucosa prior to the introduction of the probe to reduce its irritating effect (Henning et al , 1951, Marks, 1957). The question arises whether or not some of the anaesthetic reaches the stomach with the saliva and affects the secretion

of acid in it It is quite clear that distortion of its patter is not desirable since most of the procedures are perfo med exactly for more accurate determination of the acid secreting function of the stomach Taking this into accoun we decided to study the effect produced by surface anaes thesia of the oral part of the throat on the acid-secretir function

Using a three-channel pH-probe and gastropolygraph th pH of the body and intermediate and antral portions the stomach was continuously recorded. After the need data of the acid secretion were obtained, 0.2 to 0 5 ml a 2 per cent dicaine solution was sprayed by means of hand pulverizer over the visible part of the patient's thro and the gastropolygram was recorded for another 20 to minutes The result of the examination of 61 patients show that spraying of such an amount of dicaine solution on the oral part of the throat does not essentially affect th dynamic of changes in the pH of the body and intermedia and antral portions of the stomach. Thus, surface anaesth sia of the throat mucosa with up to 0.5 ml of a 2 per ce dicaine solution may be applied to facilitate the introdu tion of a probe into the oesophagus, stomach or duoden of easily excitable patients

Position of the Probe in the Stomach

When we study gastric juice by the aspiration and tration techniques we usually introduce the tube to a dep of 55 or 60 cm and assume that its end olive is in the pylo antrum But this is far from being so We were convinc of this after conducting the following examination on 1 patients.

A three-channel pH-probe of the ... Fig. 1) had a movable rubber mark introduction of the probe, was set at from the end pH-olive The probe wa the mark and its position in the ston X-ray. Contrary to our expecta... proper posit... 390 pa... average). B... ...opy show... to the left ... e, wit ... ediate pH-oli

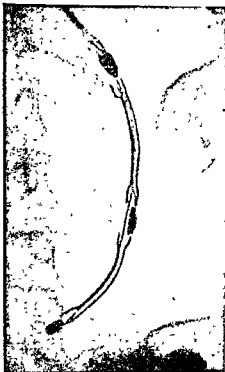



Fig. 11. X ray of patient K. Three channel pH-probe is bent in the region of the gastric fundus

to reason that the probe should be introduced deeper i[n] asthenic patients or in patients with gastroptosis than [in] persons with a normal or elevated position of the stomach.

It is quite obvious that unless the probe is in the prope[r] position described above, all its pH-olives will not b[e] located in the gastric portions for the examination of whic[h] they are intended. Consequently, all other positions o[f]

the probe should be considered faulty. The most common type of improper position is one with the probe bent in the region of the fundus of the stomach (Fig 11) It can be assumed that this is promoted by an elevated and cascade stomach, perigastric adhesions, and also by tumours of the stomach and neighbouring organs It is very difficult, or even impossible, to obtain the gastric contents (so-called 'empty stomachs') when the probe is bent here because its end, instead of being in the antral portion of the stomach, is positioned above the level of the gastric contents

There are other types of faulty positions of the probe, besides the above-described bending in the region of the fundus.

When it is found that the position of the probe in the stomach is wrong, it is necessary to correct it For this purpose the probe is pulled out under control of roentgenoscopy up to the level at which the oesophagus is continuous with the stomach, and, with the anterior abdominal wall relaxed, the patient, breathing deeply, again swallows the probe. An improper position of the probe can often be corrected with the patient lying on a sofa In this case the probe is pulled up to the level where the oesophagus is continuous with the stomach, then the patient lies on the sofa on his right side or back and swallows the probe slowly. Sometimes the probe may be set in the correct position by rotating it repeatedly about its axis when it is being swallowed.

We were able to correct the position of probes in 463 patients (31.2 per cent) by this method. In 28 cases (1 9 per cent) we failed to introduce a three-channel probe in the correct position

X-ray control over the position of the probe is now the most precise technique There are several indirect signs testifying to correct positioning of the probe in the stomach. Thus, satisfactory flow of gastric contents during fractional examination indicates, in most cases, that the end of the probe is in the antral portion Comparison of the readings of the antral and intermediate (or body) pH-olives during pH-metry of various portions of the stomach often provides valuable data in this respect. When the pH values of the antral olive are higher than those of the in-

termediate (body) olive, it can be assumed that the pro occupies the correct position. But in some patients the is no difference in the pH values of these gastric portions in which case this method cannot be applied Thus, in precise study of the medium in different parts of the upper gastro-intestinal tract, X-ray checking of the probe is currently the most reliable method.

Steel Mandrins for Easier Introduction of the Tube into the Duodenum

The shortcoming of introducing a commonly used or special duodenal tube is its deformity (twisting) in the region of the fundus of the stomach as a result of which, as X-ray shows, it cannot pass into the duodenum. In other [illegible]

sage in the region of the fundus. The general firmness of the tube cannot be increased since this will hinder its entry into the duodenum

To eliminate this drawback we proposed (Berzinsh and Leja, 1972) steel mandrins (Fig 12) which are inserted into the tube before it is swallowed The mandrins are made of steel wire with a diameter of 0.4 to 0.5 mm and 130 to 180 cm long. They have thickenings on one end for easier insertion into the tube and avoidance of damage to it, and a handle on the other end for withdrawing them

Before the procedure, two or three mandrins are wiped with alcohol and inserted into the lumen of the tube. To immobilize the mandrins in the tube the outer end of the [illegible]

separately by its handle and pulled out by 5 cm one after another. The number of grooves in the handle shows which of the mandrins has been pulled out more than the others The patient then lies on his right side and slowly swallows the tube 5 cm deeper The mandrins are pulled [illegible] more, the tube is swal[illegible] deeper and after th[illegible] drins are taken out [illegible]

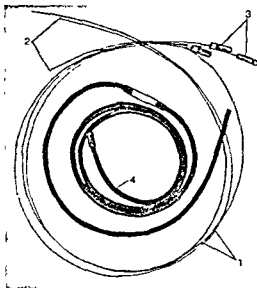



Fig 12. Steel mandrins and duodenal tube

1, steel mandrins 2, thickenings, 3 handle, 4, duodenal tube

The results of the studies showed that application of steel mandrins shortens to less than one third the time spent on intubation of the duodenum. Short-term X-ray control over the position of the tube with the mandrins in it after it has been advanced to a depth of 50 to 55 cm, ... where
e time

e tube
n-wool

(1934) and used during gastroscopy. Its value depends on a number of factors: the tone and size of the stomach, condition of the mucosa and its receptors, excitability of the patient's nervous system, etc. Nevertheless, in studying

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n patients with

(acute gastritis,

rgans, in whom

ith application

pecific features

with a definite amount of air in the balloon the motor activity of the stomach may be observed only within five minutes after which the amount of air in the balloon increases. Besides, the duration of the examination usually does not exceed 60 minutes. It is thus obvious that the duration of the 'rest' and 'work' periods of the stomach cannot be judged by such a gastropolygram though it shows at what amount of air in the balloon of the tube gastric contractions begin and at what amount they cease. At the same time the intensity and rhythm of these contractions and the threshold of the patient's subjective pressosensitivity can be assessed

Study of Gastric Acid Secretion by means of the Portable pH-Meter, Acidimechanograph and Gastropolygraph

During group examination of the gastric acid-secreting function by means of a portable pH-meter the probe of each patient is connected to one of the nine or ten operating points of this apparatus.

continuous aspiration is preferable because the examiner cannot always perform 30 manipulations within 15 minutes by the routine

cording apparatus (the latter is preferable since no need to watch continuously the changes of the the intragastric medium is recorded for ten min cases when intragastric pH is less than 2.0, the mic is pulled out to the marker and continuous recor the pH of the above-mentioned oesophageal port carried out: for 15 minutes in a sitting position the next 15 minutes in a supine position. During th the effect of deep respiration and pressure applied epigastrium on the dynamics of the oesophageal studied. Patients with a weak alkaline, neutral o acid intragastric medium (pH>2.0) are given 200 a 0.1 N hydrochloric acid solution to drink. The so is prepared in a pharmacy. Five minutes later the is again pulled out to the mark. The study is further out as described above. The examination enables watch continuously and simultaneously the pH ch in the separate portions of the oesophagus. The shift oesophageal pH from neutral to acid indicates regurgi into the oesophagus of the acid gastric contents. Th changes in the different oesophageal portions show to of its segments the gastric contents are regurgitated the patient is lying down or standing. The intensity reflux is established according to the lowest pH va and the degree of the gastro-oesophageal reflux, with patient in the given position, according to the pH s in the acid direction in the abdominal, retropericardial aortic segments of the oesophagus.

Study of the medium in certain portions of the stom A two- or three-channel pH probe is fixated in the stom der X-ray control in a correct position and the pH different portions is then simultaneously recorded fasting stomach and under the effect of a chosen ... or an agent blocking the acid secreting ...

cording apparatus (the latter is preferable ... no need to watch continuously the changes of ... the intragastric medium is recorded ... cases when intragastric pH is less than 2.0, the ... is pulled out to the marker and continuous ... the pH of the above-mentioned oesophageal ... carried out for 15 minutes in a sitting position ... the next 15 minutes in a supine position ... the effect of deep respiration and pressure ... epigastrium on the dynamics of the oesophageal ... studied. Patients with a weak alkaline, ... acid intragastric medium (pH>2.0) are given ... a 0.1 N hydrochloric acid solution to drink. The ... is prepared in a pharmacy. Five minutes later ... is again pulled out to the mark. The study is ... out as described above. The examination ... watch continuously and simultaneously the pH ... in the separate portions of the oesophagus. The ... oesophageal pH from neutral to acid indicates ... into the oesophagus of the acid gastric contents ... changes in the different oesophageal portions show ... of its segments the gastric contents are regurgitated ... the patient is lying down or standing. The intensity ... reflux is established according to the lowest ... and the degree of the gastro-oesophageal reflux ... patient in the given position, according to the ... in the acid direction in the abdominal, retropericardial ... aortic segments of the oesophagus.

Study of the medium in certain portions of the ... A two- or three-channel pH probe is fixated in ... under X-ray control in a correct position and ... its different portions is then simultaneously recorded ... on a fasting stomach and under the effect of a ... stimulant or an agent blocking the acid-secreting ... tus. Such a study, especially when combined with ... examination, makes it possible to obtain information ... the intragastric medium in the region of the pathological ... process (ulcer, polyp, cancer). At the same time more ... rate data are yielded on the character of gastric acid ... tion and maximum acid secreting capacity, which ... essential importance for non-surgical and surgical ...

Other authors also applied prolonged examination of the acid-secreting function of the stomach

Intragastric pH-metry opens up new perspectives The described method of prolonged study of the acid secreting, neutralizing and evacuation functions of the stomach by means of a pH-microprobe is of particular clinical importance in the examination of patients with continuous acid secretion (peptic ulcer of the stomach, the duodenum, etc) Thus, during prolonged study Leja and Danilans (1974) found that acid secretion in the stomach, which in patients with duodenal ulcer is of a continuous character in the morning hours, ceases in some of them in the second half of the

from other methods, this method yields more exact data which reflect the daily rhythm of acid secretion in the stomach. Hence purposeful correction of the disturbances of this function becomes possible.

Chapter

3

Gastric Acid Secretion according to the Findings of Intragastric pH-Metry

To evaluate objectively the acid secreting function of the stomach it is essential to know the normal initial state of the gastric glands. As is known, the initial state is judged by the data obtained at the beginning of the study ... basal period
The ... tion are
contra... ., 1963,
Dubra... and ex-
perime... l intra-
gastric medium to be the normal initial state. Others (Byron, 1963; Menshikov and Belousov, 1968) found hydrochloric acid in the fasting stomach of healthy people. Acid medium of the gastric contents was often found in healthy monkeys, pigs, dogs, rabbits and guinea pigs during experimental study of the initial state of the gastric glands. An acid reaction of the gastric contents at the initial state was revealed more frequently in patients with peptic ulcer and other disorders of the digestive tract than in healthy people and experimental animals (Atakhanov, 1967 and others).

Extensive study of basal gastric secretion became possible wi... of long-term
(round ... confirmed
the pre... luring the
interdig... diseases,
... ularly in those with peptic ulcer of the duodenum

It was assumed that this phenomenon is a consequence of tonic activity of the vagus (Dragstedt, 1967), which finds confirmation In most patients, for instance, the secretion reactions of the stomach diminished after vagotomy. At the same time the considerable influence of humoral factors (histamine and histamine-like substances) should be borne in mind.

In intragastric pH-metry the initial state of the gastric glands is characterized by the pH values at the beginning of the examination, before any stimulation of gastric receptors. To reveal whether or not the initial state changes due to the effect of the pH-probe itself, e g during correction of its position in the X-ray department or during other manipulations lasting for 15 to 20 minutes, we carried out the following study A three-channel pH-probe of the gastropolygraph was introduced into 139 patients without X-ray control The gastropolygraph was switched on immediately the olives of the probe had reached the oesophagus. The probe was then advanced into the stomach to the mark and the initial state of the gastric glands was recorded for 30 minutes without using any stimulants The initial state of the intragastric medium was found to be acid in 97 cases and neutral or weakly alkaline in the remaining 46 cases, in 123 cases it did not change throughout the whole period of observation. In ten patients, however, the acid intragastric medium was marked by a shift in the alkaline direction during the investigation and in six patients the beginning of gastric-acid secretion was noted on the background of neutral or weakly alkaline medium These changes usually remained within the limits of pH 2 0

It is known that in the period of rest after activity which causes diminution of functional capacity of organs the normal functional reserves of a gland are fully restored quite rapidly. The periods between digestion are the pe- [illegible]

[illegible] and easily tolerated procedures are carried out with the tube or probe early in the morning In every-day clinical

A
B
C
D
8h
Time

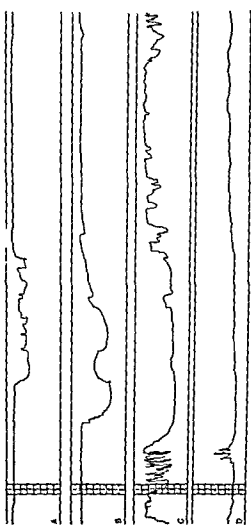
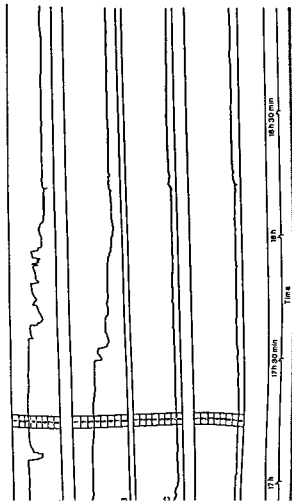



Fig 16. Gastropolygram of patient B. The same designations as in Fig 15

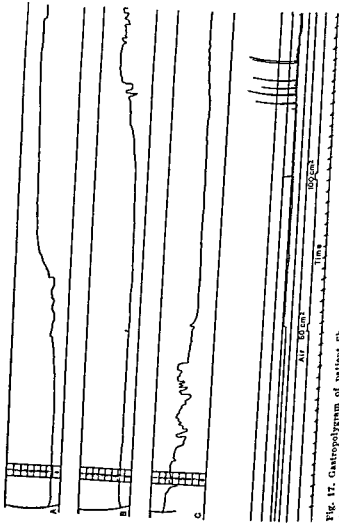



Fig. 17. Gastropolygram of patient Sh.

A, pH of the body of the stomach, B, pH of the intermediate gastric portion; C, pH of the pyloric antrum

practice, however, in heightened excitability of the gastric glands, the stimulating effect of the tube and the conditioned food reflexes should be taken into consideration since the acid-secreting function is usually examined later than the habitual time of breakfast

We have discussed two types of intragastric media on a fasting stomach, acid and neutral, or weakly alkaline, but the data which have been recently obtained at the Diagnostics Department of the CGED showed that the dynamics of changes in the intragastric pH during study of the acid-secreting function can not always be referred to the rest of the 24-hour period In other words, acid medium of a fasting stomach does not always testify to continuous round the clock gastric acid secretion To prove this we shall cite four observations

1 During 406 [illegible]

2. Among 135 patients subjected to combined examination of [illegible]

3 In order to study the nature of continuous acid secretion we conducted ten prolonged studies by means of the pH-microprobe [illegible]

may indicate that the pH-probe has not reached the required depth. Such a gastropolygram, however, was found in 2.4 per cent of the patients with correct positioning of the pH-probe confirmed by X-ray. In most of the patients the pH of the pyloric antrum increased during the study, which apparently could be explained by evacuation of the acid gastric contents into the duodenum.

These four observations show that the initial state of the intragastric medium is not always constant. It may change both in the acid and in the alkaline direction. In other words, we often have to deal with a cyclic character of the acid secreting function in appraising the initial state of the gastric glands. This is clearly shown by the first three observations. We think that the initial acid intragastric medium in the pyloric antrum (fourth observation) indicated that acid secretion had taken place but ceased when the examination was begun. The segment of the gastropolygram (see Fig. 17) shows that acid secretion in the body and intermediate portion of the stomach begins again several minutes after the acid contents have been evacuated from the pyloric antrum

Stimulants of the Acid-secreting Apparatus of the Stomach and Agents Blocking It

Numerous test and parenteral stimulants of gastric acid secretion are currently used in medical institutions. Most researchers emphasize the advantages of precisely the stimulant they use. Among the test stimulants cabbage-water which possesses a strong secretagogue effect has won the widest recognition. The effects produced by alcohol and caffeine stimulants, meat broth, peptone meal, beefsteak, bread-water, finely ground rasks, rasks-water, 10 per cent catchfly (*Silene latifolia*) infusion, gaseous stimulant, yeast, green-tea decoction, combined stimulant (alcohol + vanilla + sugar), beer and others are also considered to be favourable. At the same time it should be taken into consideration that the liquid test stimulants which are currently widely used in clinical practice have certain essential faults

First of all, they do not always have the same and constant composition, it changes depending on the quality

of the substrate from which the test stimulant is prepared, the meth[illegible]
true of [illegible]

Secon[illegible]
on the [illegible]
differs [illegible]
ach of a person who has never taken alcohol and on that of a person who abuses it. The same applies to the caffeine stimulant. There are all grounds to presume that the action of meat broth (as well as cabbage-water) in people who often eat meat will differ from that in vegetarians.

Third, test stimulants dilute the gastric contents and thus artificially reduce intragastric acidity. This factor is often decisive, as gastropolygraphic examinations show, in erroneous evaluation of the acid-secreting function of the stomach

It is quite clear that the shortcomings of the test stimulants considerably limit the reliability of the resul[illegible] obtained. Mechanical stimulation of the stomach with a balloon, complete aspiration (in a certain time interval) of an introduced test stimulant, and parenteral injection of stimulants of the acid-secreting apparatus of the stomach were suggested to improve the quality of the study and to obtain pure gastric juice Preference is given to parenteral stimulants in clinical practice. histamine, histagol (betazole), tetrapeptide and pentapeptide gastrin, insulin and others The routine histamine test with injection of 0 01 mg/kg histamine is most commonly used Some authors recognize the advantages of Kay's maximal histamine test in which 0 04 mg/kg histamine phosphate is injected Others note, however, that this test often produces side effects It is not out of place to mention here that the routine histamine test is also not infrequently poorly tolerated by the patient, who may even fall into a collaptoid state In a group of 583 patients whom we observed 2.1 per cent tolerated histamine poorly. Taking into consideration the published data, and our [illegible]

4—392

nal tract, hypotension, marked hypertension, for those with a tendency to develop allergic reactions and bronchospasm and also for patients at the age of 65 to 70.

It should be stressed that test and parenteral stimulants differ in the mechanism of action on the acid-secreting apparatus of the stomach Thus, the insulin test is used to study the first phase of gastric secretion and histamine, the second phase The humoral effect of histamine on the parietal cells differs essentially from the effect produced by the test or mechanical stimulant (through the receptor apparatus of the stomach). Nevertheless, the use of the test or mechanical stimulants makes it possible to form an opinion about the intensity of gastric acid secretion during d[illegible]
in turn,
acid-secr
that the[illegible]
one another and are equally important in the examination of the patient.

We may note that most researchers, by using various test and parenteral stimulants, strove to influence the acid-secreting function of the stomach attaching no significance to the methods of its study There are many test and parenteral stimulants and methods of their application but the technique of the assessment of the results obtained in clinical practice remains unchanged (titration method).

pH-Metry of the stomach allows a new qualitative ap-[illegible]

patient.

Histamine usually causes a more intensive secretory reaction of the gastric glands than that excited by test stimulants (Irvine et al , 197[illegible] We became convinced [illegible] this on comparing the e[illegible] routine histamine [illegible] with that of dosed [illegible] tion during ga[illegible] polygraphic [illegible] its. The hista[illegible] however, [illegible] mum acid-secr[illegible]

capacity of the gastric glands, therefore its application in all patients is not justified. In cases with initial weak-alkaline, neutral or weak-acid intragastric medium it is expedient to use widely the test stimulants which correspond to the diet of the patients being studied, or apply mechanical stimulation This gives an idea of the functional state of all the reflex and humoral links participating in gastric acid secretion (the receptor apparatus, afferent and efferent nervous pathways, gastrin producing system), and not only of the maximum acid-secreting capacity

The application of the histamine test for determining the maximum acid-secreting capacity of the stomach is justified only in persons with anacidity or with mild intragastric acidity in whom a stimulant identical with food in qualities had been used.

To improve the method of studying the acid-secreting function of the stomach, beginning with 1962, when gastrin was first obtained from the pyloric antrum mucosa (Gregory, 1964; Gregory and Tracy, 1964), work has been carried out to produce its synthetic preparations devoid of the undesirable side effects of histamine Such agents are considered the best for maximum stimulation of the gastric glands (Krikshtopaitis and Juodvalkis, 1973) The first Soviet synthetic gastrin preparation, pentagastrin, obtained at the Institute of Organic Synthesis (LSSR Academy of Sciences) was approved by the Pharmacological Committee for clinical study in 1974 We studied the effect of this preparation both in experiments and in the clinic

We carried out histamine and pentagastrin tests by the cross method in 23 experiments on four dogs (the chair of pathological physiology at the Riga Medical Institute) by using a two-channel pH-probe with a system for gastric juice aspiration and a gastropolygraph Histamine produced a somewhat more marked effect on the intragastric pH than pentagastrin, at the same time much more gastric juice was secreted in response to pentagastrin

We carried out jointly with N Skuja the pentagastrin test on 104 patients, using the portable OP-2 pH-meter 40 patients were examined twice (the histamine test was applied in the first examination and the pentagastrin test in the second) Histamine hydrochloride was injected sub-

cutaneously in a dose of 0.01 mg/kg and pentagastrin in a dose of 6 mcg (0.006 mg) per 1 kg of body weight. The body and antral pH proved to be lower in patients after the pentagastrin test than after the histamine test in all types of gastric acid secretion studied. Pentagastrin reduced the intragastric pH to low figures more often ($p > 0.001$) than histamine and led to more marked acidity of the pyloric antrum.

As a result of the studies conducted it was found that the pentagastrin test in the recommended dose (6 mcg/kg) has a stronger effect on the acid-secreting apparatus of the stomach than the routine histamine test. The patients tolerate the pentagastrin test well. It practically does not produce any side effects which is very important in the clinic. The absence of contraindications, which do exist for histamine, considerably widens the possibility of using the pentagastrin test in the clinic to determine the maximum acid-secreting capacity of the stomach.

Practice shows that when the examination is carried out in the morning the [illegible] in most patients is initially acid. Stim[illegible] tus of the stomach by [illegible] stimulant practically [illegible] the pH or does not a[illegible] Such studies yield neg[illegible] into account what is said above, we arrived at the conclusion that in patients with continuous acid secretion of high intensity (the initial intragastric pH below 2.0) the time during which the probe remains in the stomach may be considerably reduced (to 15 minutes) with practically the same results as those obtained during long-term study. In such cases the examination may not be simply limited to the study of the initial indices, but additional information may be obtained on the acid secreting function of the stomach by using the alkaline test (Pantsyrev et al., 1972).

An alkali is introduced into the stomach through a tube and the degree to which the intragastric pH increases and the time when it returns to the initial values are marked.

The possibility of using atropine as a diagnostic and prognostic test was studied in patients with continuous gastric acid secretion of high intensity in the Diagnostics

Department at the CGED (Danilans and Leja, 1970, Skuja and Danilans, 1973). The patients were examined by means of [illegible] ter using a two- [illegible] g the initial in- [illegible] ml of an 0.1 per cent atropine sulphate solution was injected subcutaneously and observation was continued for another hour The efficacy of the atropine test was estimated according to the increase of intragastric pH as high (above 2 0), medium (from 1.0 to 2 0), weak (from 0 5 to 1 0) and negligible or negative (0.5 or zero) Treatment of the data obtained from 64 patients showed that the atropine test was less effective in patients with duodenal ulcer than in those with other diseases of the gastro-intestinal tract It was also noted that this particularly applies to 'the neurovegetative variant of ulcer' The efficacy of the atropine test proved lower in clinically pronounced hypertonia of the vagus than in its normotonic state.

Combined use of cholinolytics, antihistaminics and ganglion blocking agents causes a stronger blocking effect on the acid-secreting function of the stomach. The combination of atropine and sulphate with pipolphen (promethazine) and hexonium B proved to be the most efficacious among the 30 combinations of the above-named agents used by us. Even this combination, however, could not arrest continuous gastric acid secretion in any of the patients Cautious use of ganglion blocking agents should be emphasized due to the danger of the development of orthostatic hypotension, especially in out-patients

In every-day practice we use the atropine test The results obtained yield valuable prognostic information on the expected efficacy of the action of cholinolytic agents on the acid-secreting gastric function.

In concluding the discussion of agents which stimulate and those which block the acid-secreting function of the stomach, we consider it expedient to stress again the need for an individual approach to its study. Only such an approach is up-to-date and logical. It stands to reason that it is necessary to have exact data on the intragastric medium during the examination (and not after it is completed and the gastric juice is titrated). pH-Metry of the stomach

in this respect is the most modern method of study. But due to the lack of special apparatus and pH-probes it is not used at all medical institutions as yet.

It is reasonable to use the above described principle of being orientated as to the acidity of the gastric juice from the very beginning of the examination. For this purpose slips of indicator paper, the express method for determining the pH in the aspirated portions of the gastric juice and even the titration method can be applied

Evaluation of Gastric Acid Secretion

As soon as pH-metry was introduced into clinical practice, the problem concerning the assessment of the data obtained and the interpretation of the acid-secreting function of the patient in the process of the examination arose. The old system for appraising the formation and secretion of acid in the stomach proved unacceptable since it takes into

ever wider in Soviet medical institutions for group examination of patients It provides characteristics of both the intensity of the acid-secreting function of the stomach and the dynamics of changes in the intragastric medium in the process of study, its main purpose is to obtain all basic information (sometimes not appreciable immediately) on the functional state of the stomach.

The method being described includes eight types of evaluation of the functional state of gastric acid secretion: five of them are characterized by neutral or weakly alkaline intragastric medium in the initial state and the other three by acid intragastric medium.

As we have already mentioned, a neutral or weakly alkaline intragastric medium should be considered the normal initial state of the gastric glands of a healthy individual, at this time the acid-secreting apparatus of the stomach is in a state of physiological rest When on such a background the gastric receptors are stimulated by a

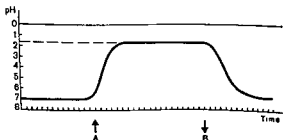



Fig 18. Schematical representation of normal secretion of acid in the stomach

A, beginning of stimulation *B*, end of stimulation

stimulant which in its qualities is close to food, then, with the acid-secretion capacity being preserved, the intragastric pH changes from alkaline to acid, i.e. the pH decreases.

Acid secretion in the stomach is considered normal when during the action of a stimulant which in its qualities is close to food the pH becomes less than 2.0 and [illegible]

gastric enzymes was optimum in the pH zone of [illegible] 1.5-2.0.

Such an ideal pattern of normal acid secretion was confirmed in experiments which we conducted [illegible] with Krampe and Rantzans (Leja et al., 1970). Seven healthy dogs with normal acid secretion were used. [illegible] gastrobiopsy was performed in the gastric body along the lesser curvature in all of them. Histological and histochemical examination of the bioptic material revealed no abnormalities in the animals [illegible]

[illegible]

in these cases that the stimulating [illegible] evidently [illegible] of the [illegible]

the conditioned food reflexes of the person under study should be taken into consideration. The atropine test which is usually effective in such cases shows the reflex nature of the phenomenon described. The functional state of the stomach in these patients is estimated as that with normal acid secretion and heightened excitability.

The evaluation of normal acid secretion is somewhat complicated by the following circumstance. In some patients with normal acid secretion the medium in the zone of the acid-secreting glands is not stably acid during stimulation of the gastric receptors, the pH of the body rises for a short time showing, as it were, the incapacity of the acid-secreting glands to perform highly effective work. The functional state of the stomach in these cases shows signs of exhaustion of the acid-secreting glands. As the result of aspiration gastrobiopsy carried out jointly with morphologists Crampe, Chernobaeva and Kalinka we found that most of such patients had gastritis with affection of the gastric glands.

There may be patients with a weakly acid intragastric medium on [illegible] after exposu[illegible] secretion wi[illegible] of the test [illegible] does not remain constantly acid but has a tendency to change in the alkaline direction testifying to exhaustion of the acid-secreting glands. As a result there seems to be normal acid secretion with heightened excitability and, simultaneously, with exhaustion of the acid-secreting apparatus, which is illogical. The morphological shifts in the fundus glands allow the conclusion that the term "normal acid secretion with exhaustion of the gastric glands" should not be used generally. This type of acid secretion in the stomach should evidently be considered as a stage leading down from continuous activity to atrophy of the acid-secreting glands.

These cases with normal acid secretion and exhaustion of the acid-secreting glands are actually related to another type of acid-secreting function according to the data of intragastric pH metry, to diminished acid secretion in the stomach. This type of acid-secreting function, just as normal acid secretion, is characterized by a neutral or weakly

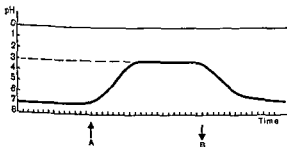



Fig 19. Schematical representation of diminished secretion of acid in the stomach The same designations as in Fig 18

alkaline initial state During chemical or mechanical stimulation of the gastric receptors the pH changes from alkaline to acid but does not drop below 2 0 (Fig 19) and does not reach the values of normal gastric acidity After stimulation is ceased the intragastric pH again increases gradually.

The incapacity of the gastric glands to produce hydrochloric acid is now called by most authors achlorhydria
g the results of titra-
In intragastric pH-
idy it is possible to
with the whole range of the pH changes in the stomach (from 0 8 to 8 0), it would be more correct to speak about the absence of the acid-secreting function of the stomach only in the presence of neutral, weakly alkaline or relatively weakly acid intragastric medium, when the pH of the intragastric contents does not drop below 6 0 (Krentz, 1966, Keel, 1968) In this case the term 'achlorhydria' is not appropriate since not in all cases of weakly acid

Fig. 20. Schematical representation of gastric anacidity The s designations as in Fig. 18

absence of all acid valencies capable of producing a wea acid intragastric medium it is more appropriate to hav mind anacidity. Achylia is a state in which the gas glands are not capable of producing both acid and enzyn

In patients with preserved acid-secreting capacity the stomach the intragastric pH during stimulation marked by a shift in the acid direction In clinical prac a test stimulant often reveals anacidity. But when s other test stimulant is given to the same patient secret of acid in the stomach occurs It stands to reason that such cases one cannot speak of real gastric anacidity. acidity may be recognized only as that revealed with given test or mechanical stimulation. In determination true gastric anacidity the clinicists should strive to est lish by functional methods atrophy of the gastric muco which sometimes cannot be done in biopsy of only portion of the stomach. The basic method for this is histamine test which is described above. In doubtful ca it is advisable to perform this test on a background o half an hour's action of antihistaminics.

The preliminary data that we have at our disposal sh that in evaluating the reaction of the acid-secreting glar by intragastric pH-metry the maximum dose of histami is not necessary, but for revealing complete atrophy of t gastric mucosa the routine histamine test is not sufficie Further studies are needed for determining the optimum d

of histamine. We use the routine histamine test in everyday practice after determining anacidity or weakly acid intragastric medium under the effect of a stimulant which is similar in its qualities to food Then we record the intragastric pH for an hour and only in the absence of an acid shift of the pH we recognize true or histamine-refractory gastric anacidity. It is exactly the term 'histamine-refractory anacidity' that should be recognized as being more suitable for designating true anacidity than the term 'histamine-resistant anacidity' (achlorhydria), since resistance as such means the capacity for resistance, the resistance of the organism to pathogenic effect, while refractoriness is a state of non-excitability.

True anacidity is determined less frequently than the other types of gastric acid secretion by the pH-metry methods Often, after obtaining an anacidity curve, e.g. in mechanical stimulation, histamine injection causes obvious change of intragastric pH from alkaline to acid, indicating acid production

The gastropolygram of patient V (Fig 21), for example, shows that the pH in the body and intermediate portion of the stomach changes from alkaline to acid in three and a half minutes after injection of 0 64 ml of a 0 1 per cent histamine solution

With a preserved acid-secreting function of the stomach the period of time between the injection of histamine and the beginning of the pH shift in the acid direction differs in the patients The degree of change of the intragastric pH after the histamine test is also different· in one group of patients the pH becomes less than 2 0 (Fig. 21), in the other it does not reach this value In evaluating the acid-secreting function we say that in the first group of patients the secretory capacity of the stomach is preserved to the level of normal acid secretion, and in the second the secretory capacity is preserved to the level of diminished acid secretion

In patient B (Fig 22) the pH of the intermediate gastric portion changed from alkaline to acid 11 minutes after histamine injection but did not reach the value of 2 0

pH of 5 0-6 0 should be considered the lowest limit at which the stomach still preserves its capacity to secrete

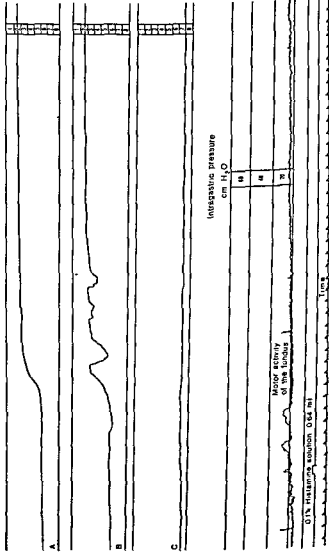



Fig. 21. Gastropolygram of patient V The same designations as in Fig 17

Intragastric pressure
cm H_2O

Time

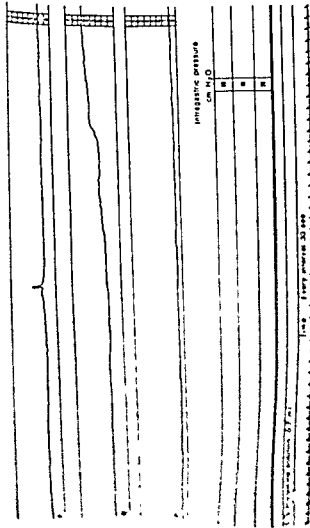



Fig. 22 [illegible] polygram of patient V. The same designations as in Fig 17

acid (Ewe and Weis, 1968). At first glance it seems that to acidify the gastric contents to such a weak acid medium (pH 5 0-6 0) an insignificant, of no practical importance amount of acic ... however stress the bufl ... that a rather ... pH from 7.0 to 4.0 or 5.0 Consequently, the types secreting function of the stomach, i.e. preserved secretory capacity to the limit of diminished or normal acid secretion have great practical importance.

A comparatively lengthy conclusion on gastric acid secretion such as 'preserved secretory capacity of the stomach to the level of normal acid secretion' is aimed at making it clear to the attending physician that gastric acid secretion in the patient is preserved to a normal level but that this is abnormal acid secretion In order to stress the essential difference between the types of gastric acid secretion it is sometimes expedient to note. 'after the histamine test'.

As it was already noted, normal acid secretion is observed only when the reflex and humoral apparatus regulating acid secretion function fully, while the preserved capacity of the stomach for secretion only shows that the parietal cells are capable of secreting hydrochloric acid under the effect of a humoral stimulator, histamine. In the latter case no other conclusions can be drawn there are no grounds for accepting that since acid secretion was revealed in the patient after the histamine test it will also take place during the digestive process, as it happens in normal acid secretion

We have already discussed the types of acid-secreting gastric function with neutral or weakly alkaline initial state of the gastric glands. Now it is necessary to dwell on acid secretion in patients who have an acid intragastric ... medium doe ...

pH, this continuous secretion has three types:

(1) continuous acid secretion of heightened intensity (intragastric pH 0.8-1.5),

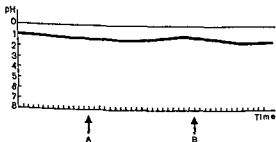



Fig 23 Schematical representation of continuous gastric acid secretion of heightened intensity The same designations as in Fig 18

(2) continuous acid secretion of medium intensity (intragastric pH 1 6-2 0) and

(3) continuous acid secretion of reduced intensity (intragastric pH 2 0-6 0).

Continuous acid secretion of heightened intensity is characterized by an acid initial state of the gastric glands (Fig. 23), during stimulation of gastric receptors the intragastric pH does not change essentially. When the stimulation is discontinued the pH remains in a strongly acid zone.

Continuous acid secretion of medium intensity, as well as that of heightened intensity, is encountered rather frequently. The intragastric pH curve is the same, in principle, as that of the heightened type of continuous acid-secreting function. The intragastric pH values of continuous acid secretion of medium intensity during the examination *correspond to* the level of normal acid formation in the stomach during stimulation of its acid-secreting apparatus. It is necessary to point out the essential difference between the discussed types of gastric acid secretion. Normal acid secretion is recognized in patients with a neutral initial state, while continuous acid secretion of medium intensity is marked by an acid initial state, i.e. by the continuous activity of the acid-secreting glands from the very beginning of the examination.

Continuous acid secretion of reduced intensity is marked by a weakly acid intragastric medium during the study (pH 2 0-6 0) The acid-secreting apparatus of the stomach cannot produce juice [illegible] ions, though some of [illegible] functional stores of t[illegible] of the histamine test [illegible] the effect of histamine in the presence of functional stores but hardly changes in their absence. The conclusion about the gastric acid secretion in this case is formulated as follows. continuous acid secretion in the stomach of reduced intensity without functional stores

It was pointed out above that hydrochloric acid can be produced in the initial state in normal acid secretion in cases with heightened excitability of the acid-secreting apparatus due to the stimulating effect of the probe and conditioned food reflexes. Consequently, the character of the intragastric pH changes in heightened excitability is similar to the character of those in continuous acid secretion of reduced intensity How can these types of acid secretion be distinguished? The answer to this question may be found more easily by applying test or mechanical stimulation under whose action in normal acid secretion the intragastric pH noticeably reduces, while with continuous acid secretion of reduced intensity such changes are not observed.

Thus, in cases with a weakly acid intragastric medium both in the initial state and during the effect of a stimulant, which in its qualities resembles food, it is necessary to check whether there is normal acid secretion. Moreover, a highly acid intragastric medium (pH less than 2 0) usually testifies to a pathological process in the organism. It should be considered incorrect to include into control groups patients who do not complain of only gastro-intestinal disorders, which is often practiced during studies. It has been established that extragastric (at times latent) pathological processes affect the functional condition of the stomach.

A comparison of the functional data of intragastric pH-metry with the morphological picture of the gastric mucosa showed that in most cases with continuous acid secretion

of heightened intensity the mucosa was unchanged or superficial gastritis had developed With the appearance of functional symptoms of exhaustion of the acid-secreting glands, however, the incidence of superficial gastritis with the involvement of the glands increases This regular pattern was also noted in cases with continuous acid secretion of medium intensity. At the same time, gastritis with the involvement of the glands was diagnosed in most of the patients with continuous acid secretion of reduced intensity. Normal gastric mucosa was practically not encountered in reduced acid secretion with acid-secreting capacity preserved to values of normal or reduced acid secretion and in histamine-refractory anacidity

In joint studies with Chernobaeva and Kalinka, we found that the effectiveness of the atropine test grows with the appearance of symptoms of exhaustion of the gastric acid-secreting glands This phenomenon occurred in cases with continuous acid secretion both of the heightened and of medium intensity. The parallelism was also observed when the effectiveness of the atropine test was compared with the morphological structure of the gastric mucosa. Thus, in patients with continuous acid secretion of heightened intensity and normal structure of the gastric mucosa the atropine test was usually negative or weakly positive, in those with superficial gastritis weakly or mildly positive, while in patients with gastritis with involvement of the glands it was mildly or sharply positive. Thus, the effectiveness of the atropine test increases both with the more
Ir [illegible]
at [illegible]
ir [illegible]
u. [illegible]

q [illegible] acid secretion
is evidence of a certain exhaustion of the acid-secreting apparatus of the stomach Histological material obtained shows that the structural shifts in the gastric mucosa during this type of acid secretion are pronounced in the same degree as those in continuous acid secretion of heightened intensity. The same applies to the effectiveness of the atropine test. These facts do not give grounds for considering

continuous acid secretion of medium intensity to be a form of partial exhaustion of the acid-secreting glands

The frequency of the types of gastric acid secretion discussed is confirmed by the results of examination of 2000 patients at the Diagnostics Department of CGED (1972) continuous acid secretion of heightened intensity was revealed in 710 patients, of medium intensity in 353, of reduced intensity in 226, normal acid secretion was found in 316 patients and reduced in 209, preserved secretory capacity of the stomach to the level of normal acid secretion was determined in 87, and to the level of reduced acid secretion in 50 patients, and histamine-refractory anacidity was revealed in 49 patients.

It should be noted that not all changes of intragastric pH revealed during examination can be fully evaluated by the types of gastric acid secretion discussed. In such cases the character of the pH dynamics should be described. For example, in some cases continuous acid secretion determined in the initial state ceases of itself without the application of any agent stimulating or blocking the acid-secreting apparatus and then, in a certain period of time, recommences Such a type of gastric acid secretion is usually observed during long-term studies We believe that in evaluating it both the intensity of the acid-secreting function and its cyclic or phase process should be reflected e g. cyclic gastric acid secretion of heightened intensity

The basic method for evaluating the acidity of the aspirated gastric juice is titration. Titration with a 0.1 N solution of sodium peroxide in the presence of two indicators, dimethylamino azobenzene and phenolphthalein, is widely used in clinical practice. This method has a number of shortcomings: inaccurate indicator, inaccuracy of the titration and of the methods of preparing and storing the solution used for titration (Linar, 1968). Certain authors doubt the value of determining free hydrochloric acid, consider the terms 'free' hydrochloric acid and 'total' acidity to be obsolete and recommend that they not be used (Moore and Scarlata, 1965, Keel, 1967).

For better evaluation of the aspirated gastric juice, titration with phenol red or under control of a pH-mete is used in certain clinics. But these methods are also n quite adequate because aspiration of the juice is limite

Measurement of intragastric pH is a new method of stud in principle and is aimed not at analysing the aspirate gastric juice but at determining the intragastric medium. Teleradiometry and acidimechanography should be mentione among the methods used in our country for determining th pH. They make it possible to watch continuously the change of intragastric pH during the examination and to detec all its short-lived changes which are not seen when the gas tric contents are collected by the fractional method.

Thus, the methods of studying the acid-secreting func tion of the stomach have been developed in the followin way: one-stage examination by the Boas-Ewald techniqu fractional aspiration of gastric juice, methods of obtainin pure gastric juice, titration of gastric juice with phen red or under control of a pH meter and, finally, determina tion of intragastric pH. All these methods are now used i the clinic and their tendency to improve is developing i this way.

The results of titration in 27 laboratories of Riga o 11 standard solutions prepared according to the range o intragastric pH changes from 1.0 to 8.0 showed that fre hydrochloric acid is determined only in highly acid gastr contents with pH of 2.5 and less. In standard solution with pH 3.0 and more it was not revealed. Such result could be expected because free hydrochloric acid is titrated

in the presence of dimethylamino azobenzene indicator with the dye beginning to pass into the solution when pH is 2 9

It is easy to understand why after the examination gastric anacidity is diagnosed in patients with a weakly acid medium in the pyloric antrum where during fractional study of the stomach the tube olive is located Therefore, in examination of aspirated gastric juice it is not possible to trace the short-lived and slight changes of the intragastric medium and the acidity of the gastric juice in samples the pH of which exceeds 2 5-3 0. It can be suggested that this partly explains the large number of cases with gastric anacidity and heterochylia (Lorie, 1958) diagnosed during fractional study and the frequent lack of coincidence of the results of this study with the morphological findings and the clinical picture Determination of the pH of the gastric contents by titration with phenol red should be considered more exact, though the results of this method are also inaccurate, because the pH is determined outside the stomach, where this index may change

Intragastric pH-metry is devoid of the above-mentioned shortcomings and justifiably finds wider use in clinics (Fursova, 1972, Belousov, 1973, Sadnikova, 1973, Sumlyaninova and Akinfova, 1973) Determination of the pH of one portion of the stomach, however, is not a full-value method for studying its acid secretion in the clinic so it is necessary to study the pH of different gastric portions.

pH of Different Portions of the Stomach

Man
ago th
tions
ance
stresse
the pyloric portion obtained on a fasting stomach has an

It was shown that the chief and parietal cells are located in the body and fundus of the stomach, while the pyloric

portion has practically no parietal cells This portion i lined with pyloric glands consisting of mucous, accessor and chief cells which produce an alkaline secretion. Thus it should be considered as established that the gastric gland may be divided at least into two zones: an upper zone which is acid secreting and corresponds along the lesse curvature to the body and intermediate portion, and lower zone, which is neutralizing and corresponds to th pyloro-antral portion of the stomach

The facts established testifying to the presence in th

or weakly alkaline intragastric medium Normal gastric acid secretion was found in 110 patients and diminished in 111 patients The studies were conducted by the three-channel probe with olives for determining the medium in the body, and intermediate portion and in the antrum. The position of the probe was checked by roentgenoscopy.

secretion of acid begins in the upper portion It is logica so assume that the antrum is 'acidified' by the acid gastric juice of the proximal acid-producing zone.

When discussing the types of evaluation of gastric acid secretion according to the data of intragastric pH-metry, for simpler presentation of the material, we only spoke about the pH of one gastric portion, the pH of the acid producing zone It is necessary to mention here that the data obtained are more complicated since they characterise

not only the intragastric medium in the zone of the acid-secreting but also that in the zone of the neutralizing glands In analysing these data it is necessary to consider not only the dynamics of the medium in various gastric portions but also the correlations between them and to evaluate the function of the stomach in its entirety.

Frequently in elaborating for the clinic a new method of study or treatment its actual possibilities are exaggerated Eventually, with the accumulation of extensive factual material, the method does not live up to expectations and is forgotten. To avoid such untimely conclusions in respect of the practical application of intragastric pH-metry, we decided to subject it to all-round clinical checking We took into [illegible]
of one [illegible]
The fc[illegible]
tragastric pH-metry and by the method of gastric juice aspiration were carried out

1 Comparison of the results of gastropolygraphy with the results obtained by the examination of aspirated gastric juice (according to the data of medical history) The results of previously conducted one-stage or fractional examination of aspirated gastric juice were collected from the medical histories of 1390 patients after gastropolygraphic studies. The results of titration were unknown in 139 patients, hyperacidity during the last three years was established in 266, normal acidity in 167, subnormal acidity in 338 and anacidity in 480 patients Continuous acid secretion of increased or medium intensity was established by gastropolygraphy in most patients with hyperacidity revealed by titration This type of acid-secreting function of the stomach was observed also in most patients with normal and subnormal acidity determined previously by titration. Many patients with established anacidity had a neutral or weakly alkaline intragastric medium in the ini-[illegible]

[illegible] stage of [illegible] [illegible]-pulated gastric se-cretion, gastropolygraphy demonstrated preserved acid-secreting capacity

2. In 153 patients the results yielded by gastropolygraphy were compared with the results of previous tests, supplied by clinical laboratories. Among the 62 patients with titration anacidity confirmed by means of gastropolygraphy histamine-refractory anacidity was confirmed in only five, i e in 8.1 per cent of the cases.

The analysis of the results shows that higher acid-secreting capacity of the stomach is revealed by gastropolygraphy than by the method of gastric juice aspiration. [illegible] inten- [illegible]
In the group of patients with titration anacidity, continuous acid secretion of heightened and medium intensity was observed more frequently than histamine-refractory anacidity.

The results yielded by gastropolygraphy and those obtained by the methods of gastric juice aspiration were compared by the non-parametric test of signs; it proved natural for the first method to demonstrate higher values. This may evidently be explained both by the more extensive range of observations over the acid-secreting function in determining the activity of hydrogen ions in general and by the examination of the pH of various portions of the stomach by gastropolygraphy which provides information on the intragastric medium of both the lower and the upper gastric portions.

[illegible] 1952 [illegible]
clinical hospital. The results of fractional tests of gastric secretion were as follows: hyperacidity in 1952-1961, anacidity in 1962, normal acidity in 1963-1965; anacidity in 1966 Such changes in the acid-secreting function of the stomach could hardly be explained by the course of the disease, so in 1966 gastropolygraphy was carried out during which continuous acid secretion of heightened intensity was revealed (Fig 21).

In such a case it is difficult to believe the data of fractional method for the years of 1962-1966.

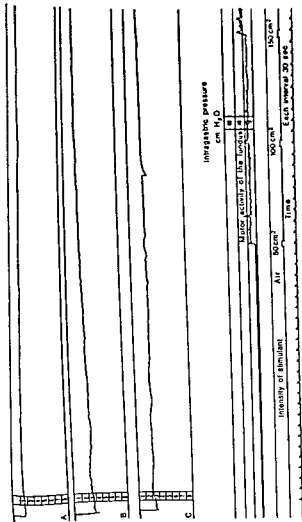



Fig 24 Gastropolygram of patient A The same designations as in Fig 17

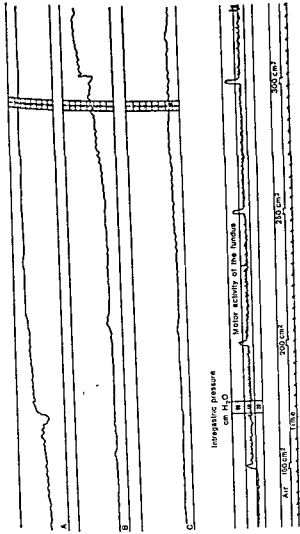



Fig 25. Gastropolygram of patient K The same designations as in Fig. 17

The previously revealed regular pattern was demonstrated: gastropolygraphy showed values of gastric acid secretio which were higher, than those revealed simultaneously b the titration method.

Continuous acid secretion of heightened intensity wa found by means of pH-metry in 16 patients in whom hy peracidity was established by titration.

According to the data of intragastric pH-metry, norma acid secretion was found in only six of 23 patients with nor mal acidity established by titration. In the other 17 pa tients continuous acid secretion of heightened or mediun intensity was revealed

With the application of test stimulants the values o intragastric pH in the group of patients with subnorma acidity or anacidity established by titration testified t higher acid-secreting activity

Among the three series of investigations free hydrochloric acid was found in the gastric juice in the initial state in 33 patients In the process of study it was established that in most of them the amount of free hydrochloric acid considerably diminished after the test stimulant was introduced. This phenomenon may be explained by the diluting effect of the test stimulant. It was more marked when a 5 per cent solution of ethyl alcohol or a caffeine stimulant was used In only six patients the amount of free hydrochloric acid in aspirated fractions of the gastric juice did not diminish after the test stimulant was administered. At the same time in another six patients this diminution was so prolonged that the amount of free hydrochloric acid did not reach the initial values 55 minutes after the test stimulant was administered In two of them after adm of the test stimulant (in one case cab n other a 5 per cent solution of ethy chloric acid was not found in any of

A part of the gastropolygram shown in Fig. 26, from which diluting effect of dried-cal strated *false anacidity*. Tl continuous acid secretion

More careful analysis (Leja, 1971) showed

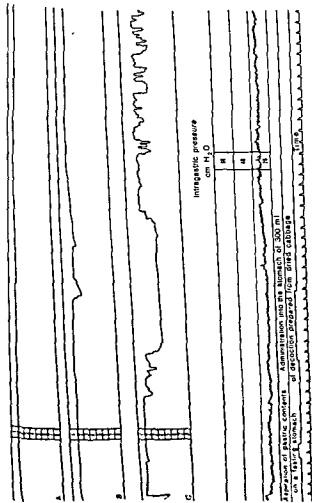



Fig. 26. Gastropolygram of patient P The same designations as in Fig 17

the results of fractional study for half an hour and sometimes more. In preserved gastric acid secretion, acid gastric juice flowing from the upper portions of the stomach is neutralized, partly or completely, by the mucus of the pyloric glands and is diluted by the test stimulant remaining after aspiration. It is not out of place to mention here that even with X-ray control of the position of the probe one cannot be sure that the test stimulant was aspirated completely, since without the use of a contrast medium it is not possible to establish that the olive of the probe is below and not above the gastric contents. Therefore, when titration demonstrated a certain amount of free hydrochloric acid in the gastric juice, we must bear in mind that the amount of the acid in the upper gastric portions is much higher. When no free hydrochloric acid is revealed by the titration method one should bear in mind that the probability of the gastric acid secretion being preserved in the given patient is still very high.

4. It is necessary to discuss the following indices: the hour-yield of free hydrochloric acid, the acid and alkaline components of gastric secretion, the acid-alkaline coefficient, the hour tension of gastric secretion and the data concerning intragastric pH. The advantages of calculating these indices in clinical practice have recently been stressed by certain authors. In order to check this we examined 200 patients with different acid-secreting capacity of the stomach. A two-channel pH-probe with a system for collecting gastric juice and an OP-2 portable pH-meter were used. The examination was continued for two hours: basal gastric secretion was studied during the first and secretion after the routine histamine test during the second hour. The hour tension of gastric secretion was calculated from the sum of the volumes of all gastric juice fractions collected within an hour, the hour yield of free hydrochloric acid was calculated by the common method (Shilov and Fishzon-Ilyes, 19[illegible]2) and the acid and alkaline components by the Thompson-Vane formula (Thompson and Vane, 195[illegible]). Finally, taking into account Fishzon-Ilyes' (19[illegible]5) critical remarks about Kostyuk's formula for calculating the acid-alkaline coefficient (AAC) we calculated it by using both Kostyuk's and Fishzon-Ilyes' formulas.

Analysis of the data obtained showed that these indices practically always increased after histamine administration Comparison of the hour-yield of free hydrochloric acid with the type of gastric acid secretion, determined by pH-metry, did not reveal any strict parallelism between these indices.

The hour-yield of free hydrochloric acid was increased in most patients with continuous acid secretion of heightened intensity and remained within the normal limits in those with continuous acid secretion of medium intensity and in those with normal acid secretion A zero hour-yield was found in all patients with histamine-refractory gastric anacidity. Such a phenomenon may be considered logical but not in respect of patients with preserved acid-secreting gastric capacity A zero value of the hour-yield of free hydrochloric acid, however, was encountered in them and even in patients with continuous acid secretion of medium and heightened intensity The average AAC values, according to Kostyuk and Fishzon-Ryss, are practically identical in patients with continuous acid secretion of various intensity as well as in patients with normal and diminished acid secretion and with histamine-refractory anacidity

Generalizing the data obtained it should be stressed that all the indices of gastric acid secretion depend on the amount of hydrochloric acid determined by titration Thus, for example, the hour-yield of free hydrochloric acid reflects its hour secretion only when titration of the gastric juice shows the presence of free hydrochloric acid in it When the pH of the aspirated gastric juice exceeds 2 5-3 0, hydrochloric acid is not found though in this case strongly acid secretion is often produced in the upper portions of the stomach. As a result the free hydrochloric acid hour-yield is zero Thus, inaccuracy in calculation of these indices is due to the faults of the titration method which determines the amount of hydrochloric acid in a mixed secretion (combined secretion of the gastric secreting and neutralizing glands).

We do not deny the possibilities of calculating the hour tension of gastric secretion, the hour-yield of free hydrochloric acid and the alkaline component of the gastric secretion, the AAC and other indices in clinical practice They

supply many physicians with valuable additional d
on the secretory and acid-producing gastric function, wh
are undoubtedly of a wider scope than the commonly
termined data (... acid
total acidity of ... il sh
comings of thes ... the
tration method should be taken into consideration it sta
to reason that even the most complex calculations can
produce clinically important information on the acid
creting and neutralizing functions of the stomach beca
part of the acid in the common gastric secretions has
ready been neutralized.

At the same time, examination of the whole volume
the secreted gastric juice is of clinical interest also in
termining the pH of the acid-secreting and neutrali
gastric zones since it characterizes the secretory acti
of the stomach (the volume of gastric juice of defi
acidity).

In joint study with Antsan we analysed the results
the examination of 141 patients with continuous gas
acid secretion of heightened and medium intensity.
amount of active hydrogen ions was calculated by me
of Garshin's nomogram (Garshin, 1972) for determining
rate of secretion of hydrogen ions in the gastric juice.
is necessary to note that the rate of elimination of hyd
gen ions by th ... be est
lished from a
ume of gastric
gastric zone ha
gram, however, yields data about the amount of hydro
ions in the gastric juice, which is also essential for
clinic It was noted that the average amount of act
hydrogen ions in all examined groups was higher in ma
than in females All indices of continuous gastric acid
cretion of heightened intensity exceeded the indices of co
tinuous acid secretion of medium intensity.

The amount of active hydrogen ions in patients with t
same pH in the acid-secreting gastric zone but differe

of patients in whom the pH of the antral portion was higher than the pH of the body (satisfactory secretion of mucus) The average amount of active hydrogen ions in the first group always exceeded that in the second group This parallel persisted in the examination of both the basal secretion and the secretion after the atropine test It shows more marked neutralizing properties of mucus from the pyloric portion in the second group of patients with similar pH indices in the acid-secreting zone of the stomach In this case the mucus may essentially reduce the amount of active hydrogen ions as if partly compensating for continuous acid secretion.

Finally, the [illegible]

[illegible] active hydrogen ions in gastric juice is a valuable index. Together with the pH of the acid-secreting gastric zone it provides the possibility to study objectively the acid-producing and secretory functions of the stomach

These data taken together prove that the results of determining the amount of hydrochloric acid by the titration method are inaccurate and inferior to the results of intragastric pH-metry. In modern conditions, methods involving aspiration of gastric juice do not comply with the requirements of the clinic, therefore it is necessary to use methods for studying the pH in the zones of the acid-secreting and neutralizing gastric glands. Simple portable pH-meters with two-channel pH-probes are fully suitable for every-day use in the clinic.

Chapter 5

Diagnosis of Anacidity and Continuous Acid Secretion in the Stomach

Accurate identification of gastric anacidity is important not only from the standpoint of the application of proper treatment, but also because the condition is considered precancer The last circumstance is widely known among the population and affects many people mentally since anacidity is often demonstrated by aspiration methods

With the development of new methods of study in gastroenterology many facts have been accumulated which cast doubt on the diagnosis of gastric anacidity. Many authors (Glass, 1960, Melikova et al , 1970) came to the conclusion that determination of the amount of hydrochloric acid by titration is not sufficiently exact for the diagnosis of anacidity The term 'false anacidity' or 'achlorhydria' is used more and more widely in the literature There is no doubt that this state is not true anacidity of the stomach but simply one of the various types of preserved gastric acid secretion Only lack of acidity caused by atrophy of the gastric mucosa should be recognized as histamine-refractory or true anacidity

Histamine-refractory gastric anacidity is encountered rarely Among the people in whom anacidity was revealed by the titration method true (histamine refractory) anacidity was confirmed by pH metry in only 8 1 to 12 6 per cent, i e in one out of ten patients

True, or histamine refractory, anacidity can recently be

diagnosed only after studying the pH in the zones of acid-secreting and neutralizing gastric glands and application of the histamine test.

Continuous Gastric Acid Secretion

Examination in the m[illegible] continuous acid secretion to be the most con[illegible]
of the stomach at that [illegible]
concerning the cause [illegible]
continuous acid secretion is of particular practical value.

This question was raised by clinicists and physiologists previously but inaccuracies of the titration method prevented its study. Nevertheless, it was revealed that secretion of hydrochloric acid in a healthy organism has an interrupted character. Continuous, or spontaneous, secretion of gastric juice was observed in humans and experimental animals with peptic ulcer and also in those with hyperparathyroidism, adenoma of the pancreas or certain inflammatory diseases.

The study of this widely-spread type of acid-secreting function of the stomach, which brings much trouble to man, is being continued on a new methodological level

While studying case histories of patients with continuous acid secretion in the stomach we noted that extragastric inflammatory processes, such as diseases of the biliary tract, pancreatitis, appendicitis, inflammatory diseases of the upper respiratory tract, the intestine and subcutaneous fat, were most often attended with this type of acid secretion

We analysed the results of study of 141 patients with diseases of the biliary tract (hepatocholangitis, cholecystitis [illegible]

to five years, from five to ten years, and over ten years

diminished

Intragastric pressure
cm H_2O

Air 60 cm³

100 cm³

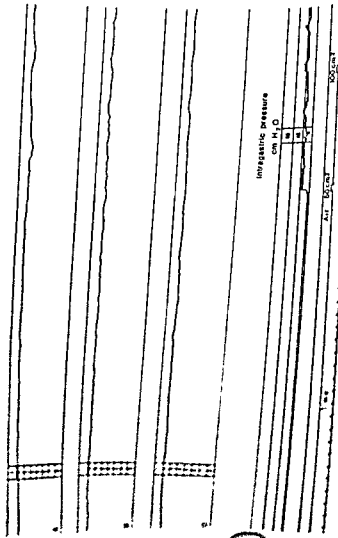
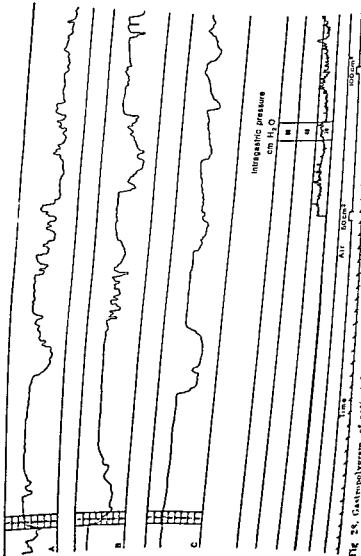



Fig. [illegible] Gastropolygram of patient 7. The same designations as in Fig. 17

Fig. 29. Gastropolygram of patient

pH, 121 biopsies of the stomach and made 62 injections of turpentine (the work was performed jointly with Krampe and Ranzan).

In the first part of the work subcutaneous abscesses were reproduced in seven dogs after normal gastric acid secretion in the initial state had been established, and the pH of various portions of the stomach was recorded by means of a gastropolygraph on the 3rd, 5th, 8th, 12th and 17th day after the injection of the turpentine solution On the 3rd day continuous acid secretion was found in all dogs (Fig. 30) of heightened intensity in four and of medium intensity in three dogs. The subcutaneous abscesses were opened on the 6th to 12th day after injection of the turpentine solution. The acid-secreting function by this time normalized in two dogs, while in five animals it was still characterized by continuous acid secretion Parallel histological examination showed no changes in the gastric mucosa. Con...

y process in this ex-
nctional changes At
ic changes (gastritis)
of the acid-secreting
glands is of essential significance for the clinic because here the matter is concerned with the pathogenetic treatment of such a common disease as chronic gastritis

To confirm the important role of continuous acid secretion in the development of morphological changes in the gastric mucosa we continued experimental studies. After the initial functional and morphological data were obtained subcutaneous abscesses were reproduced again in six dogs. Injection of turpentine solution was repeated after continuous acid secretion had ceased. Thus, in these experiments continuous acid secretion was maintained for a long time by repeated reproduction of abscesses. Aspiration

to Nachlas' method. The rest of the material was fixated by Carnoy's fluid and embedded in paraffin. PAS reaction was performed on paraffin sections for determining glucosamine glycines. To discover RNA the preparations

were stained with methylene green pyronine according to Brachet. Survey preparations were stained with haemato-xylin-eosin.

The duration of the experiment was from five to seven months. In the second half the working capacity of the gastric acid-secreting glands showed a tendency to decrease Continuous acid secretion of heightened intensity was established less often In those cases where it was observed its intensity diminished in several days or continuous secretion ceased altogether In individual cases the formation of an infiltration or abscess was not attended with continuous acid secretion or the secretion was of a reduced intensity In three dogs the initial morphological changes were revealed on the 18th, 21st and 22nd day after the first injection of turpentine solution The surface of the gastric mucosa was covered with mucus At places the surface epithelium was indurated and in separate cells a small amount of PAS-positive material was observed Oedema of the mucous layer proper developed between the gastric pits PAS-positive granules appeared in individual chief cells of the gastric glands Similar changes in the other three animals were found only 36, 43 and 47 days after turpentine had been administered for the first time

During dynamic study of the structure of the gastric mucosa in maintained continuous acid secretion we found that its deeper layers became involved in the morphological changes The amount of PAS-positive material in the surface epithelium reduced and induration became pronounced Separate tortuous gastric pits of different depth were visible, in three dogs the connective tissue of the mucous layer proper proliferated in 56 to 57 days and grew between the gastric glands The glands were arranged in groups PAS-positive granules were observed in many chief and in individual parietal cells In the other three dogs such changes were encountered on the 65th, 76th and 85th day of the experiment Succinate dehydrogenase activity in the parietal cells was high at the beginning of the experiment and decreased after 97 days. The oxyphilic properties of the parietal cells also diminished in staining with haematoxylin-eosin These changes became deeper during the . .

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Fig. 30 Gastropolygram of a dog on the third day after subcutaneous injection of turpentine solution The same designations as in Fig. 17

Consequently, the first structural changes in the gastric mucosa in our experiments were revealed 18 to 47 days following the ... s acid secretion ... tis Morphological ... hic gastritis were ... to 85th day of the experiment. Connective tissue of the mucous layer proper began growing between the gastric glands but there was no leucocytic infiltration Leucocytic infiltration, just as in the initial state, proved to be insignificant Thus, these changes in gastric mucosa characterize exhaustion of the glandular structures without symptoms of inflammation

Continuous acid secretion (of heightened or medium intensity) and a normal gastric mucosa are also observed in clinical conditions at the beginning of an inflammatory extragastric disease With a protracted inflammatory extragastric process the symptoms of chronic gastritis become apparent. In these observations and in our experiment there is a certain parallelism proceeding from which the pathogenesis of chronic gastritis (secondary or endogenous) can be really explained. We see the picture of its development to be as follows: the extragastric inflammatory process (furuncle ...

... be supposed, varies in different patients, continuous acid secretion leads to exhaustion of the acid-secreting glands. Examination of patients reveals continuous acid secretion of medium or reduced intensity A phase of organic changes in the structure of the gastric mucosa begins with changes in the activity of the respiratory enzymes and then the diagnosis of chronic gastritis is confirmed by aspiration biopsy.

Blockade of Continuous Acid Secretion

Questions relating to inhibition of heightened gastric acid secretion have long been concern of clinicists. The data yielded by intragastric pH-metry indicate that the

effect of antacids used for neutralization of hydrochloric acid in the stomach is short-lived and their application is often unjustified. Medicinal agents blocking gastric acid-secreting activity are divided into several types according to their effect: agents inhibiting the reflex effects, they usually diminish the vagus effect (atropine and ganglion blocking agents), inhibiting hormones (they include substances reducing gastrin secretion—procaine, atropine), and also preparations inhibiting secretory activity (enterogastron).

The greatest number of investigations of blockade of gastric acid secretion was performed by using atropine. Atropine is applied as a standard cholinolytic agent. Its effect designated by some authors drug vagotomy consists in reducing the intensity of gastric secretion and evacuation (Belousov, 1969, Demand and Fürst, 1969, and others). Under the effect of ganglion-blocking agents the acid-secreting function was reduced (Denisenko, 1968; Limbosch et al., 1968, and others). Neither atropine nor ganglion-blocking agents, however, could arrest acid secretion in all cases.

Data on the increased blood histamine level in patients with heightened acid-secreting function of the stomach (Eidelman, 1967; Mozhaiskaya, 1967) made it possible to put in the foreground the role of histamine and histamine-like substances in the origin and maintenance of heightened and continuous acid secretion in this organ. In view of this, great hopes were placed on antihistamine preparations but testing of their effect showed that they did not inhibit the activity of the parietal cells and did not hinder the development of experimental gastric ulcers (Lin et al., 1962).

It has been established that histamine spent on hydrochloric acid secretion is rapidly replaced by intensified decarboxylation of histidine (Albinus and Sewing, 1969). It was logical to expect that acid secretion would cease when these enzymes are blocked but experimental appli- [illegible] tors either did not [illegible] (Thayer and Mar- [illegible] imidt and Martini, 1968). Finally, it [illegible] educe the level of

connection was established between blood circulation a metabolic processes in the gastric mucosa and intragast temperature

The diagnosis of gastric diseases may be promoted more precise information is gained on the relations exi ing between intragastric temperature and the basic functic of the stomach. Gastropolygraphic measurement of the p and temperature in various gastric portions under expe mental and clinical conditions (Leja, 1971) showed that t temperature curves of the acid secreting and neutralizi gastric zones do not change noticeably during intragast pH shifts from alkaline to acid and from acid to alkalin But the absence of an obvious increase or diminution intragastric temperature during the pH changes does n indicate the absence of exo- and endothermal reactions the glandular tissue of the stomach during its activ (the process of production of hydrochloric acid is link with energy expenditure). Gastric temperature simply flects the degree of balancing of these processes in t given area of the gastric mucosa

It may be assumed that the value of intragastric te perature is linked with the state of the acid-product apparatus. Evidence of this is the lower intragastric te perature during mechanical stimulation in patients w anacidity in comparison with the temperature of a secreti stomach.

Diminution of temperature of different portions of t stomach during its contractions was recorded on gastr polygrams The temperature of the intermediate porti changed most of all (sometimes by 0 5 to 0.9 °C), less the temperature of the antral portion and still less th of the body of the stomach. The temperature of differe gastric portions did not change or changed slightly in t period of 'hunger' contractions as compared to the perio of 'rest'. the gastropolygrams showed certain decrease temperature.

... ts and al
' the less
the dire
tion from the body to the ... may prol
ably be connected with the swallowing of saliva and a

function of the stomach. This is confirmed by the following data.

We examined the gastropolygrams of 284 patients with gastric or duodenal ulcer diagnosed in the clinic. They were divided into four groups according to the term of the disease. up to one year, from one to five years, from five to ten years and over ten years. Anacidity was noted in none of the cases. Moreover, in 94 per cent of cases with gastric ulcer and in 96.2 per cent of those with duodenal ulcer the acid-secreting function of the stomach in the morning was characterized by continuous acid secretion of various intensity. Neutral intragastric medium was encountered in only individual cases, mostly in patients with a chronic course of the disease.

Information on previous methods of aspiration of gastric juice was collected in 70 patients with peptic ulcer. Hyperacidity had been established in ten out of 26 patients with gastric ulcer, normal acidity in seven, subnormal acidity in another seven, and anacidity in two patients. Among the 44 patients with duodenal ulcer, hyperacidity had been ascertained in 31, normal acidity in 10, subnormal acidity in two patients and anacidity in one patient. These results fully agree with literary data but differ considerably from the results of intragastric pH-metry.

The indices of gastric acid secretion in patients with duodenal ulcer were basically higher than those in patients with gastric ulcer. In most patients with duodenal ulcer, even with a long history of the disease, continuous acid secretion of heightened intensity was revealed. Analysis showed that the intensity of continuous acid secretion was somewhat reduced with an increase in the duration of the disease, which may be associated with the exhaustion of the acid-secreting gastric apparatus.

The patients were divided into three groups according to the localization of the ulcer: ulcer of the subcardial portion and body of the stomach, ulcer of the pyloric antrum, ulcer of the pylorus and duodenal ulcer. It was established that the acid-secreting function is more marked in patients with ulcer localized in the pylorus, its antrum, and the duodenum than in cases of ulcer of the subcardial portion. While these data with respect to the intensity of gastric
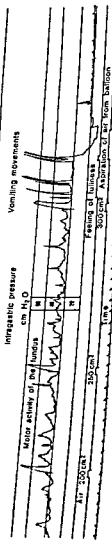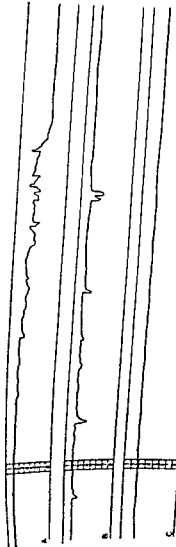
Fig 31. Gastropolygram of patient N. The same designations

(3) the ulcer has cicatrized, (4) malignant degeneration of the ulcer takes place.

We shall briefly dwell on the interpretation of a record of gastric motor activity on the gastropolygram in functional diagnosis of peptic ulcer. While watching intensified gastric contractions in hampered evacuation from the stomach (Fig. 32), we noted that some patients suffering from gastric ulcer felt pain in the epigastrium during these contractions (they pressed the pedal of the marker of subjective pressosensitivity). The occurrence of such pain during gastric contractions was compared repeatedly by Linar and Leja with the X-ray data of the stomach in the same patients and was called 'the symptom of pain waves'. Below we give a section of the gastropolygram of patient M (Fig. 33) as an illustration.

In weak and moderate mechanical stimulation of the stomach, [illegible]
e waves of gas-
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h an old non
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Though the 'symptom of pain waves' is not always positive in gastric ulcer it has certain diagnostic significance. We think that this symptom occurs in the following way: during contraction the gastric wall touches the partially inflated balloon of the probe, at this moment the afferent nervous apparatus carrying pain impulses is switched on. The patient feels pain and presses the pedal of subjective pressosensitivity. When the contraction ceases the gastric wall relaxes and the pain passes. Positive 'symptom of pain waves' is observed in patients with ulcers of the upper and middle third of the stomach, it is exactly these portions that touch the inflated balloon during contraction of the gastric wall.

No significant differences were found in examining the [illegible]
of a dosed
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[illegible]

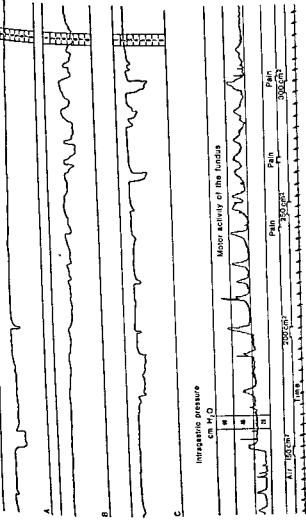



Fig. 33. Gastropolygram of patient M. The same designations as in Fig 17

the threshold of subjective pressosensitivity (SPT) wa lower in patients with gastric ulcer than in those wit duodenal ulcer The difference between the mean values this *index was more pronounced in patients with a shor* term of the disease It [illegible] increase of the duration [illegible] tric ulcer, especially [illegible] two thirds, often noted discomfort when the SPT [illegible] reached: they experienced nausea, disagreeable sensation be low the pit of the stomach, mild pain, etc Most of th patients with duodenal ulcer noted only a feeling of full ness in such cases

Cancer of the Stomach

Gastric cancer is one of the commonest types of malig nant tumours, the early diagnosis of which is of essentia importance for the successful treatment It is necessary to collect gastric contents for examination and to determine the amount of hydrochloric acid in it The acid-secreting function of the stomach is of interest to many clinicists, particularly oncologists, not only in cases of malignant tumours but also in revealing anacid gastritis, a precancerous state of the stomach, for which the patient should be subject to regular all-round examination in an oncological clinic

Methods employing aspiration of gastric juice in gastric cancer patients most frequently show anacidity or sharply reduced acidity of the gastric juice (Swynnerton and Truelove, 1952, Masevich, 1967, and others) Taking into consideration the shortcomings which are described above we carry out gastropolygraphic studies

We examined 104 patients with gastric cancer using a three-channel pH-probe These were mainly patients in whom stages III and IV cancer were verified in a hospital In only five patients stage II gastric cancer was diagnosed The acid secretion in the stomach was preserved in most of them, even in those with stage IV carcinoma. The frequency of anacidity of the stomach increased in parallel with the stage of malignant neoplasm. In the initial state neutral [illegible] medium was found in a[illegible] [illegible]pa-

tients and continuous acid secretion in the rest A large group (29 2 per cent) was composed of patients with continuous acid secretion of reduced intensity The intragastric medium in these cases during the whole examination, and also after the histamine test, was weakly acid (pH 3 0-5 0) (Fig. 34) Thus, the acid-secreting function in patients with gastric cancer in the group with continuous acid secretion of reduced intensity was characterized by persistent sluggishness. Besides that, a large group (20 8 per cent) was

ctory

4 per

test

ypes

acid secretion in patients suffering from gastric cancer, diminished acid secretion (13 5 per cent) and continuous acid secretion of medium intensity (11 5 per cent) were observed

In only 21 9 per cent of gastric cancer patients studied by us there was continuous acid secretion of heightened or medium intensity (normal acid secretion was found only in three patients) In the other cases acid secretion was diminished or there was anacidity We have all grounds for presuming that methods involving aspiration of gastric juice would have demonstrated anacidity in most of our patients with continuous acid secretion of reduced intensity and in those with diminished acid secretion This is the circumstance that can explain the difference between the data obtained by methods with aspiration of gastric juice and those yielded by intragastric pH-metry in gastric cancer patients.

In comparing the acid-secreting function of the stomach and the localization of the malignant neoplasm it was observed that histamine-refractory anacidity was the most frequent finding (35 6 per cent) in patients in whom cancer was localized in the upper two thirds of the stomach, while continuous acid secretion of reduced intensity in patients with localization of the cancer in the lower third (37 5 per cent) We may presume that in the first group of patients this is associated with involvement into the tumour of the acid-producing zone, and in the second group—with accumulation in the stomach of other organic acids, besides

Intragastric pressure
cm H_2O

Time
Air 50 cm³
100 cm³
150 cm³

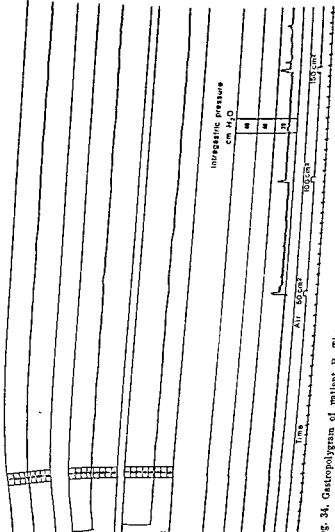



Fig. 34. Gastropolygram of patient P. The same designations as in Fig. 17

hydrochloric acid, due to intensified process of glycolysis in the tumorous tissue and to the fermentation of gastric contents due to impaired evacuation

A similar picture of continuous acid secretion of reduced intensity may be observed in ulcers of the upper and middle third of the stomach whose clinical course is less pronounced It is known that these ulcers often become malignant in the chronic stage. Hence, in our opinion, an essential conclusion for practical [illegible] its with con[illegible] be subject [illegible] stands for [illegible] should be differentiated from those which are due to chronic extragastric inflammatory processes

The data of intragastric pH metry which have been accumulated up to the present time indicate that surgical intervention is needed for patients with continuous acid secretion of reduced intensity and an X ray symptom of niche since malignant degeneration is possible in such cases This also applies to patients with initial neutral, weakly alkaline or weakly acid intragastric medium and with a niche in the lower third of the stomach

To obtain data on the frequency of the types of gastric acid secretion in patients with various diseases of the gastro-intestinal tract, including those with gastric cancer, we studied the final diagnosis in all in patients who were examined by the OP-2 portable pH-meter in the Diagnostics Department at the Center of Gastroenterology and Dietetics Continuous gastric acid secretion was established in most of the examined patients (1080) of heightened intensity in 41 8 per cent, of medium intensity in 19 2 per cent and of reduced intensity in 12 3 per cent of cases Gastric cancer was diagnosed during further clinical examination in 16 patients. Continuous acid secretion of reduced intensity and histamine-refractory anacidity were the most frequent findings. Continuous acid secretion of heightened intensity was revealed in two patients

While comparing the frequency of various types of acid secretion in patients with chronic gastritis and gastric ulcer, i e. the diseases which most often need to be differentiated from gastric cancer, it was found that the greatest

distinctions exist between the groups of patients suff ing from ulcer of the stomach (continuous acid secret of heightened intensity is prevalent) and cancer of t organ

As it follows from what has been said above, true a cidity with intragastric pH level of 5.0-8.0 is encounter in the smallest number of patients with malignant gast tumour Besides that, histamine-refractory anacidity w quite an unexpected finding in rather young people so of whom practically had no complaints of gastro-intesti disorders No pathological changes were found in care clinical examination of the stomach. Hence another pro lem which is of importance for practical oncology arises regular all-round medical examination of all patients wi anacidity expedient? This question requires careful chec ing and rather long analysis, it is necessary to study t dynamics of changes in patients with histamine-refracto anacidity. As regards the all-round medical examinati in cases of precancerous conditions only the following h pothetic conclusions can be made

Anacidity of the stomach cannot be considered a preca cerous condition if it is revealed by titration of aspirat gastric juice Histamine-refractory anacidity revealed b means of intragastric pH-metry is associated, in certa cases, with a malignant lesion of the stomach, but pr longed dynamic studies are needed in such cases Patien with continuous gastric acid secretion of reduced inte sity and complaints of dyspepsia are subject to obligator all-round medical examination in an oncological institu tion, while those with an X-ray symptom of niche an continuous acid secretion of reduced intensity and als

the first half of the gastromechanogram ... amount of air in the probe balloon (50 to 300 cm^3). The ... of arrhythmic contractions is explained by the

affection of the gastric nerve apparatus with a mal
tumour At the same time, in other patients the
mechanogram is characterized by rhythmic motor ac
In some patients there were no gastric contractions
the whole period of study

A high threshold of subjective pressosensitivity
is observed in patients suffering from gastric cancer
is often no threshold even when the maximum amo
air is introduced into the balloon. Malignant ne
is sometimes attended with mildly pronounced SPT
of the patients noted a feeling of fullness in the e
trium) or there is no threshold A comparatively hi
mildly pronounced SPT is evidence in favour of th
gested inhibition of afferent nervous impulses in t
sease

Taking into account the high incidence of gastric
and the small effectiveness of prophylactic examin
the search for new means of early diagnosis of this d
acquires particular importance Stage by stage forn
of groups of people with a high risk of gastric cancer
to be one of such means (Stengrewitz et al, 1974).
suggested that at the first stage case histories which
tain certain points related to the risk of gastric
are initially selected At the second stage selection is
by means of laboratory tests (haemoglobin level, da
intragastric pH-metry, etc) At the third stage th
lection is continued by X-ray examination of the co
gent of people with a high risk of gastric cancer with
sequent all-round medical examination of some of th
tients and their further study (gastroscopy, gastrobio

A Stomach Subjected to Surgery

application in clinical ...
state after gastroenterostomy. Yudin in his book ...
... (Sketches of Gastric Surgery) ...

72 to 100 per cent of cases (Pechatnikova and Kuznetsov, 1969, and others) Certain authors (Steger and Weis, 1955, Sitenko and Samokhvalov, 1968, Samokhvalov et al, 1972) believe that the appearance of free hydrochloric acid in the gastric stump is a grave disturbance in stump function leading to the development of peptic ulcers

At the same time intragastric pH-metry shows a far lesser number of cases with anacidity after resection of the stomach We studied the functional state of the gastric stump by means of a three-channel pH-probe and gastropolygraph in 142 patients after various types of resection Most of them (122 patients) had undergone resection of two thirds of the stomach for peptic ulcer. In the other 20 patients subtotal resection or resection of two thirds of the stomach had been carried out for malignant neoplasms. Assuming that acid secretion in the gastric stump might be associated with the postresection syndrome, in addition to the 97 patients admitted to the clinic because they complained of dyspeptic disorders after operation, we specially invited 25 patients to check their condition by gastropolygraphy three months and one year after surgery, but patients with no complaints of dyspepsia were chosen.

The main result of this examination was that preserved acid secretion of the gastric stump was found in most patients In only 15 out of 97 patients (15 5 per cent) histamine-refractory anacidity was established. In the first 12 months after stoma ... refractory anacidity of the gastr ... group of patients admi ... specially invited for ... acid secretion is detected only in remote periods after resection

Continuous acid secretion in the stump was observed in 26.8 per cent of patients admitted to the hospital and in 20 per cent of those called for examination. The main distinction between these groups of patients was the differ intensity of continuous acid secretion. In a grou tients admitted to the hospital (15.5 per ... number) continuous acid secretion medium intensity, while in the ... examination such types of

This was evidenced by diminution of the gastric stump pH during mechanical stimulation or after the histamine test.

[illegible]

in the abdomen and was admitted to our hospital Examination showed no cancer recurrence Diminished acid secretion was established by gastropolygraphy

Neutral or weakly alkaline medium in the gastric stump in the initial state was established in 91 out of 122 patients with two thirds of the stomach resected for peptic ulcer. It can be assumed that this neutral or weakly alkaline medium is the main advantage of the resection since gastric and duodenal ulcer is characterized by continuous gastric acid secretion

The stump of a resected stomach differs greatly from a stomach which had not been operated on In most cases the pyloric antrum and intermediate portion of the stomach are resected, these are the portions responsible for the local self-regulating mechanisms of its activity Besides that, and what is no less important, with resection of the pyloric antrum a powerful area of mucus production is removed a mucous barrier between the acid medium in the stomach on one side, and neutral or weakly acid in the duodenum on the other The absence of postresection continuous acid secretion n [illegible]
associated [illegible]
glands and [illegible]
lating and [illegible]

Continuous acid secretion of heightened or medium intensity in the gastric stump should be considered a grave disturbance of the function of the gastro-intestinal tract As a result of it, the strongly acid gastric contents enter the intestine without being neutralized by the mucus of the antral portion, which promotes the development f peptic ulcer Continuous acid secretion of heightened tensity in the gastric stump may also indicate that the tient has the Zollinger-Ellison syndrome

[illegible] acid secretion of reduced intensity [illegible] examination [illegible]
[illegible] of the patients invited for examination [illegible]
[illegible] character of residual phenomena of peptic ulcer

Continuous acid secretion of heightened or medium intensity in [illegible] out of 97 patients admitted to the hospital was characterized by strongly acid medium in the stump (pH less than 2.0) from the very beginning of the study (Fig [illegible]). The pH of the stump was in the acid zone during the whole study. It should be noted that in patients with continuous acid secretion of heightened or medium intensity in the gastric stump the disease is characterized by a more severe clinical course. They complain of pain in the region of the gastric stump, in the region of the small intestine (particularly in its upper portion) and in the right hypochondrium. Some of these patients suffer from recurrent ulcers of the gastric stump and the initial portion of the small intestine.

There were eight patients with peptic ulcer of the gastric stump or small intestine diagnosed by X-ray. Continuous acid secretion of heightened intensity was established in three of them, of medium intensity in one, diminished acid secretion in two, preserved secretory capacity to the level of normal acid secretion in one, and histamine-refractory anacidity in one patient. In the last case the pain was localized mainly in the right hypochondrium and during roentgenoscopy of the stomach convergence of the mucosal folds of the gastric stump was found and tenderness was elicited, on the grounds of which peptic ulcer of the gastric stump was suspected.

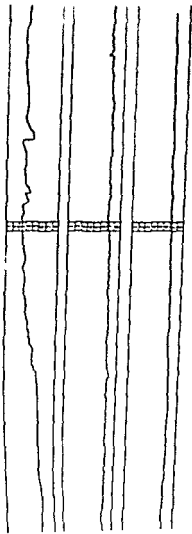
Gastropolygraphic data confirm once again that "there is no ulcer without acid". They do not confirm, however, the assumption that peptic ulcers of the gastric stump, anastomosis or of the small intestine develop often or even [illegible] acid secr[illegible]

Analysis of the data of intragastric pH-metry of patients who underwent resection of the stomach suggests that the excitation threshold of the acid-secreting apparatus of the stump diminishes in comparison with its level in the stomach with peptic ulcer before the operation This is evidenced by the cessation of continuous acid secretion after resection, despite the preserved acid-secreting capacity of the gastric stump, and the diminution of its maximum acid-secreting capacity It may be assumed that the diminished excitability of the acid producing glands is connected with the removal of the pyloric antrum and intermediate gastric portion due to which secretion of hydrochloric acid with the participation of gastrin ceases

Finally, we consider it expedient to emphasize once again that the acid-secreting activity of the stump of a stomach resected for peptic ulcer is preserved in most patients. It is to the point to mention here that acid secretion in the stump is inhibited to a greater degree in resection of two thirds of the stomach for polyposis or a malignant neoplasm than after resection for peptic ulcer

It is necessary to note the great practical importance of intragastric pH-metry in examination of the medium of the gastric stump Clinicists know that in these cases the amount of gastric juice collected by aspiration is not sufficient for titration, and that sometimes gastric juice cannot be aspirated at all This can be explained by a wide gastro-intestinal anastomosis, rapid evacuation of the gastric contents from the stump, comparatively small production of gastric juice after resection and by other factors Methods used occasionally in such cases in which during aspiration of the gastric contents the gastro intestinal anastomosis is blocked with a balloon to prevent the evacuation of gastric juice from the stump, are not physiological The method of measuring the pH directly in the gastric stump and in the region of the gastro-intestinal anastomosis is devoid of these shortcomings

Comparison of the average threshold of subjective pressosensitivity shows its higher values in patients invited for examination than in those admitted to the hospital This phenomenon apparently evidences higher excitabili

tric pressure
H O
Motor activity of gastric stump
150cm²
200cm²
atient Yu

study of the functional state of the stomach in the surgical and gastroenterological clinic but also for making the procedure easier and reducing the duration of the examination, e g by combined examination of the gastric and duodenal function, studies with pH-microprobes, etc The new data obtained make it possible to comprehend in a new light the acid-secreting function of the stomach in the most common gastro-intestinal diseases and after surgical interventions on the stomach They also help in prescribing the proper treatment We believe that these promising methods of study will be developed further in the nearest future, and will considerably improve the quality of examination and predetermined treatment of a large number of patients suffering from gastro-intestinal diseases

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